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1 Intended Use for Oxylog 2000

Oxylog 2000 - Time-controlled, volume-constant emergency ventilator for patients as of 100 mL tidal volume.

For the following modes:

- Controlled ventilation IPPV with variable TI:TE, adjustable to 60 or 100 % by vol. O2
- Synchronised intermittent mandatory ventilation SIMV
- Spontaneous breathing with positive airway pressure CPAP

With monitoring of:

- Airway pressure Paw
- Expiratory minute volume MV

And checks on:

- Airway pressure
- Power supply
- Gas supply

Applications:

- Mobile use in emergency situations or for initial care of emergency patients
- Transportation of patients in rescue vehicles or helicopters
- Transfer of patients by road or air
- Relocation of patients receiving ventilation within a hospital
- In emergency admissions department
- Secondary transportation from hospital to hospital

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1.1 Intended Use for Oxylog 2000 HBO

Oxylog 2000 HBO is a time-controlled, constant-volume emergency ventilation unit for patients with a tidal volume of 100 mL or more.

Ventilation Mode:

- controlled ventilation IPPV with variable TI:TE, adjustable to 60 or 100 vol% O_2
- synchronized, intermediate mandatory ventilation SIMV
- spontaneous ventilation under positive airway pressure CPAP

Monitoring:

- of the airway pressure Paw
- of the expiratory minute volume MV using Volumeter 3000 for reliable measuring quantities for the VT and MV
- of the airway pressure
- of the electrical power supply
- of the gas supply

Areas of Operation:

- Mobility is possible for emergency applications or pre-hospital emergency care in hyperbaric chamber.

  Areas of operation are limited to the immediate vicinity within and around the HBO chamber.
  Oxylog 2000 HBO is suitable for up to a maximum of 3 bar = 300 kPa absolute (20 m depth).

  Attention!
  Oxylog 2000 HBO should only be used with the patient hose system described in the User's Manual (Instructions for Use).

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2 For your safety and that of your Patients

Ventilation monitoring

Patients should be constantly supervised by appropriately qualified staff during ventilation.

Provision of manual ventilator

In the event of a ventilator fault, e.g. failure of the power supply, where the life-support function is no longer guaranteed, there must be immediate provision for further ventilation of the patient with a different device such as a manual breathing bag - where appropriate with PEEP and/or a higher inspiratory O_2 concentration.

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3 Order Governing Medical Equipment (MedGV)

In line with MedGV the device is a group 1 unit.

The deadline for safety checks as per para. 11 MedGV is two years.

The device must be subjected every two years to inspection and maintenance by specialist personnel and a record kept.

Standards

Degree of protection	IP 54 (splash-proof)
Power-pack safety class	II Q as per DIN IEC 601

Manufacturer's interference-suppression certification

In line with EN 55014: 1987/A2 1990 it is hereby certified that the Oxylog 2000 features interference suppression and that noise immunity as per Directive 89/336/EEC is guaranteed.

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4 Important technical data

Control principle:	Volume metering; time-controlled, volume-constant flow chopper. Spontaneous breathing with integrated demand valve (also at PEEP level)
Ventilation modes:	IPPV, SIMV/CPAP
Ventilation frequency (f):	5 - 40 min.-1 ± 1
TI:TE ratio:	1:3 to 2:1 ± 5 %
Tidal volume (VT):	0.1 - 1.5 L ± 10 %
Minute volume MV:	min. 1.0 to max. 25.0 L/min. (with TI:TE = 1:1.5)
Insp. pressure limit:	20 - 60 mbar ± 10 % (Pmax.)
PEEP:	0 - 15 mbar
Response pressure of demand valve:	approx. -1 mbar
Delivery capacity at -4 mbar:	approx. 120 L/min.
Measuring range, pressure gauge:	-10 to 80 mbar ± 2 mbar
Range, flow measurement:	2 - 120 L/min.
Range, MV measurement:	2 - 40 L/min.
O_2 concentration	
AIR MIX:	> 7 L/min. approx. 60 % by vol. < 7 L/min. up to approx. 80 % by vol.
NO AIR MIX:	100 % by vol.

Refer to operating manual for further data. Data given in manual are binding.

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5 Presentation of the Operating Modes

5.1 IPPV

(Intermittent Positive Pressure Ventilation)

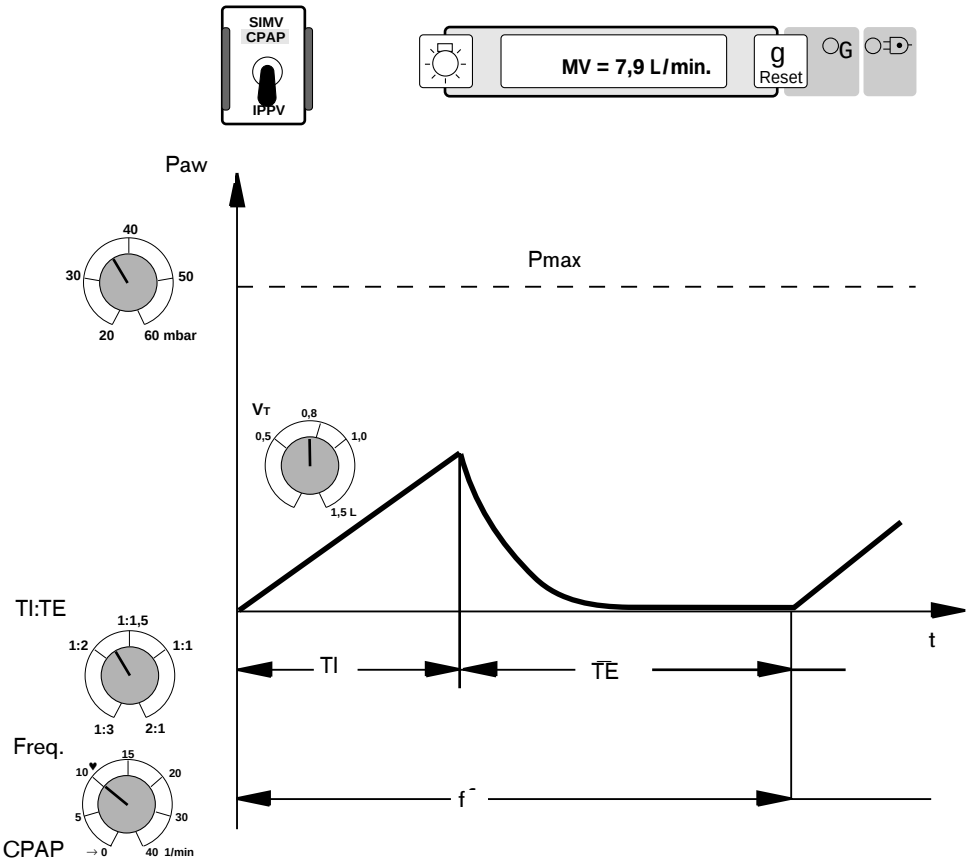

Fig. 1: IPPV diagram

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5.2 IPPV, Paw Low Alarm

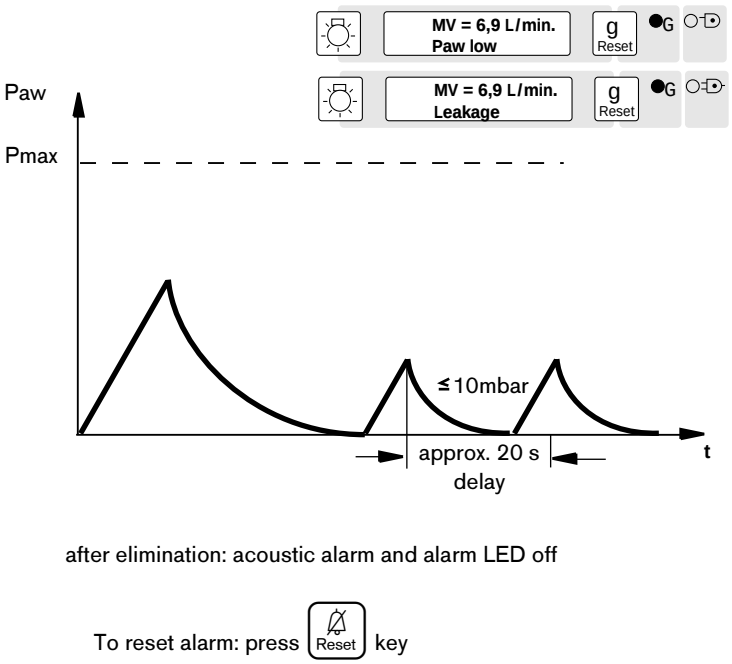

Fig. 2: IPPV, Paw Low Alarm

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5.3 IPPV, High Alarm

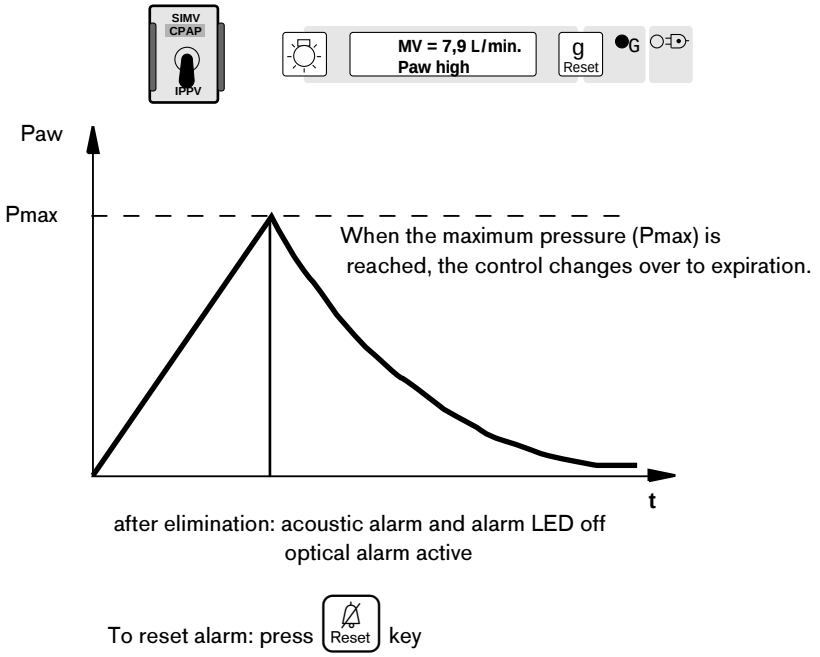

Fig. 3: IPPV, Paw High Alarm

If the Paw high alarm goes off, the set tidal volume V_T is not fully applied.

For software 3.xx and higher versions, the rotary selector can be used to set the Pmax to 80 mbar. This setting limits the airway pressure to a maximum of 80 mbar without shutting off inspiration too early (pressure-limited ventilation). A single tone signalizes the pressure limit. The set tidal volume V_T is not fully applied.

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5.4 IPPV, Leakage-Alarm

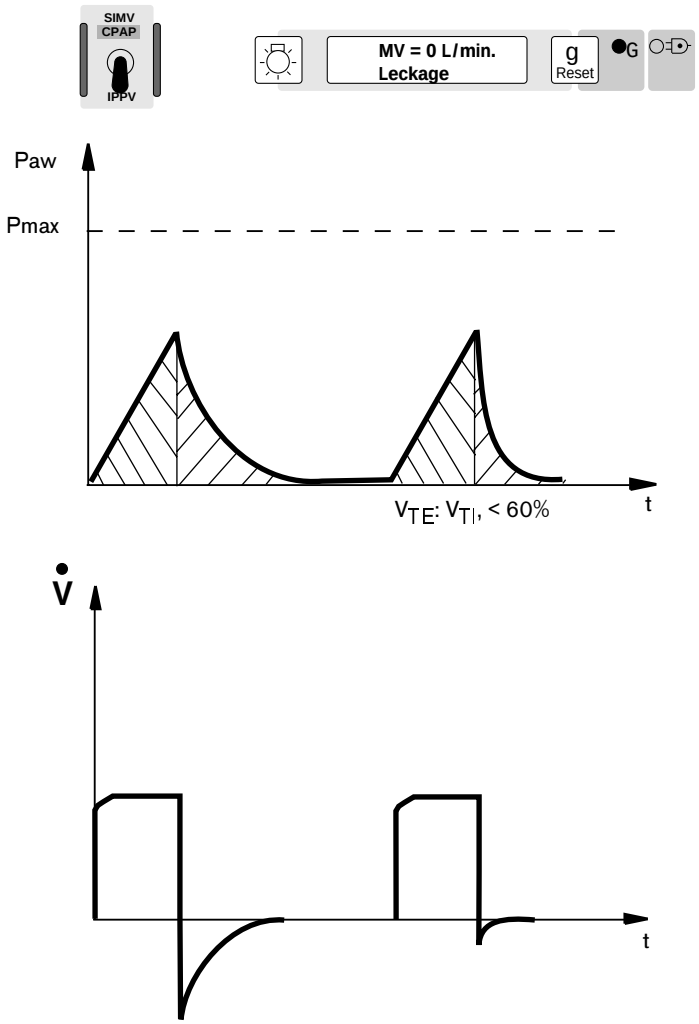

Fig. 4: IPPV, leakage alarm

The V_{TE}:V_{TI} ratio is checked independent of the minute volume and the frequency settings.

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5.5 SIPPV (Synchronized IPPV)

The operating mode SIPPV is available for software 3.xx and all higher software versions.

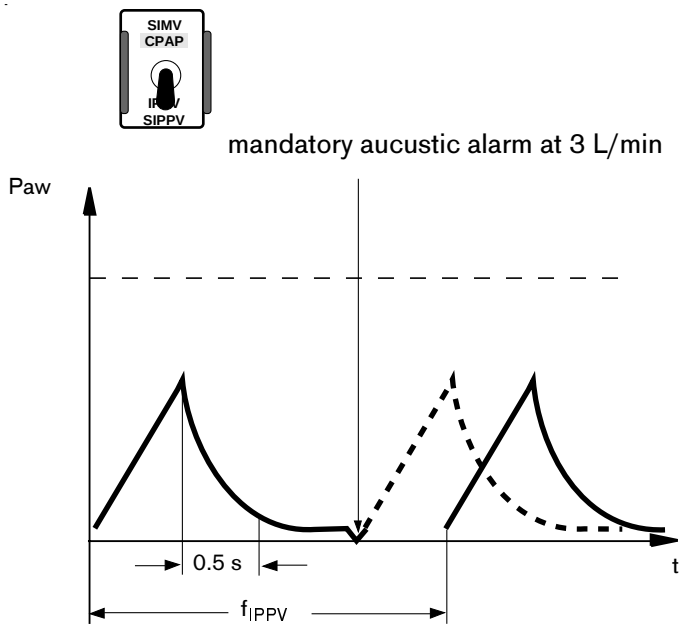

Fig. 5: SIPPV

If the patient triggers trigger expectation screen, the frequence per minute will be increased.

To switch to the SIPPV operating mode, the operting mode switch should first be set to SIPPV. Using the INFO key, SIPPV should then be selected on the display screen and chosen using the RESET key.

If the measured frequency is higher than the set frequency by more than 50%, the alarm message “High Frequency” is displayed.

The maximum inspiration time is limited to 1.3 seconds.

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5.6 IPPV with PEEP (CPPV)

(**C**ontinuous **P**ositive **P**ressure **V**entilation)

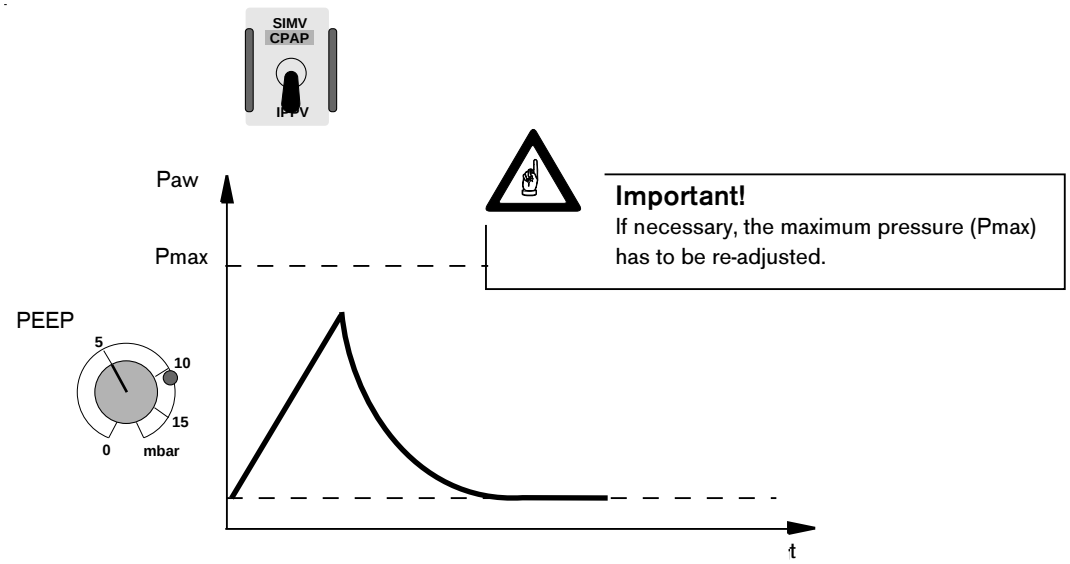

Fig. 6: IPPV with PEEP

The alarms are the same as described under IPPV.

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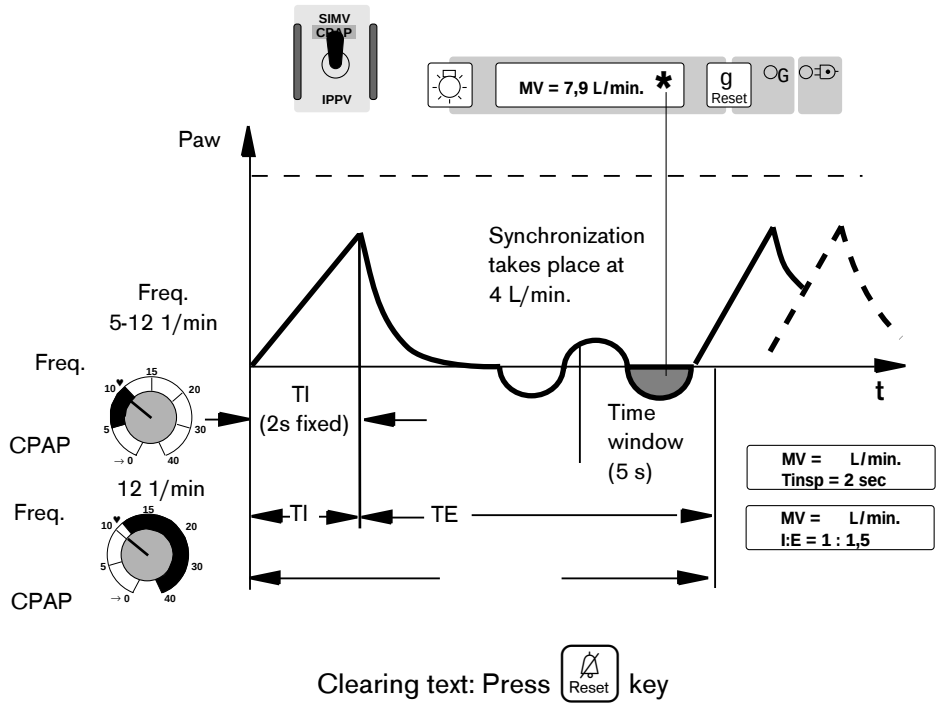
5.7 SIMV

(**S**ynchronized **I**ntermittent **M**andatory **V**entilation)



The alarms and the PEEP are the same as described in IPPV.

Important!
The trigger window is activated with the SIMV mode

Fig. 7: SIMV

The following is valid for software 3.xx and all higher versions:

frequency 5 - 18.5 1/min T_{insp} : 1.3 seconds (permanent)
>18.5 1/min T_I:T_E : 1.5 seconds (permanent)

Das Triggerfenster ist ab SW 3.XX 6 Sekunden lang.

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5.8 SIMV Trigger window

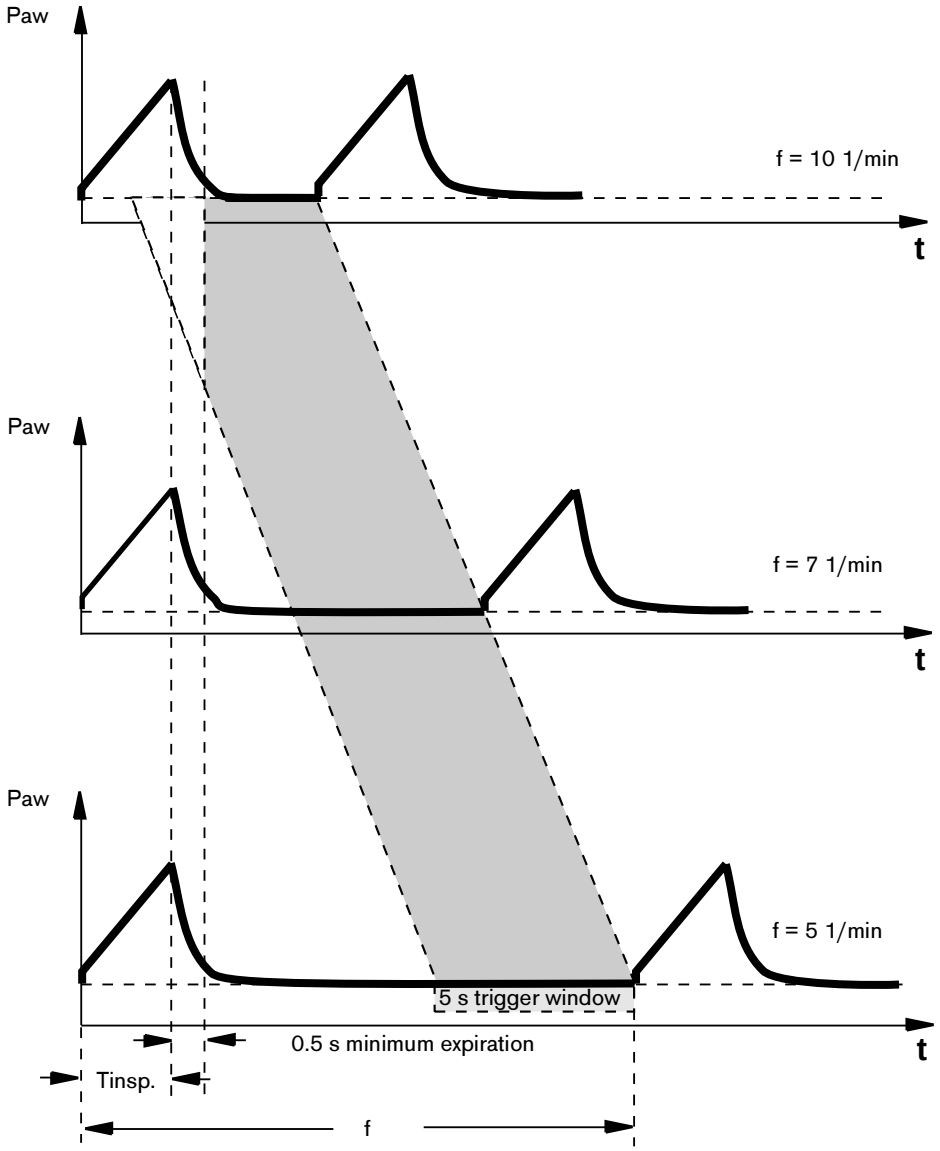

Fig. 8: SIMV trigger window

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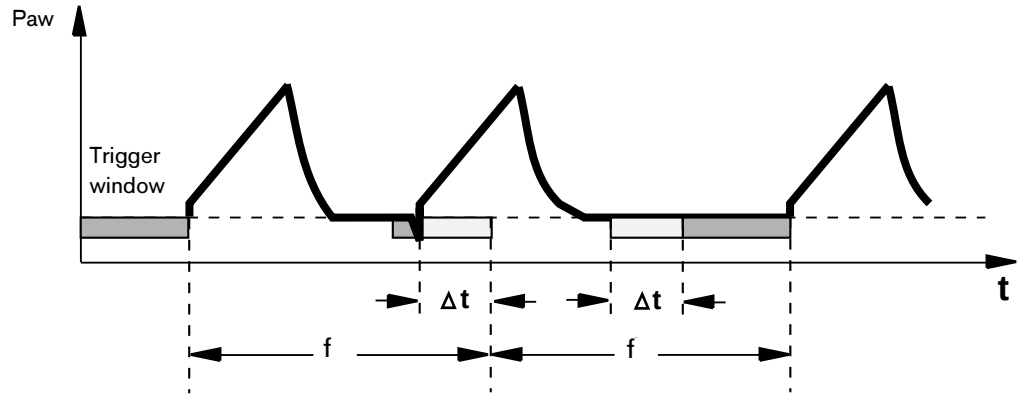
5.9 Fixed SIMV frequency



Important!

The frequency of the mechanical ventilation strokes remains constant.

Fig. 9: Fixed SIMV frequency

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5.10 CPAP

(**C**ontinuous **P**ositive **A**irway **P**ressure)

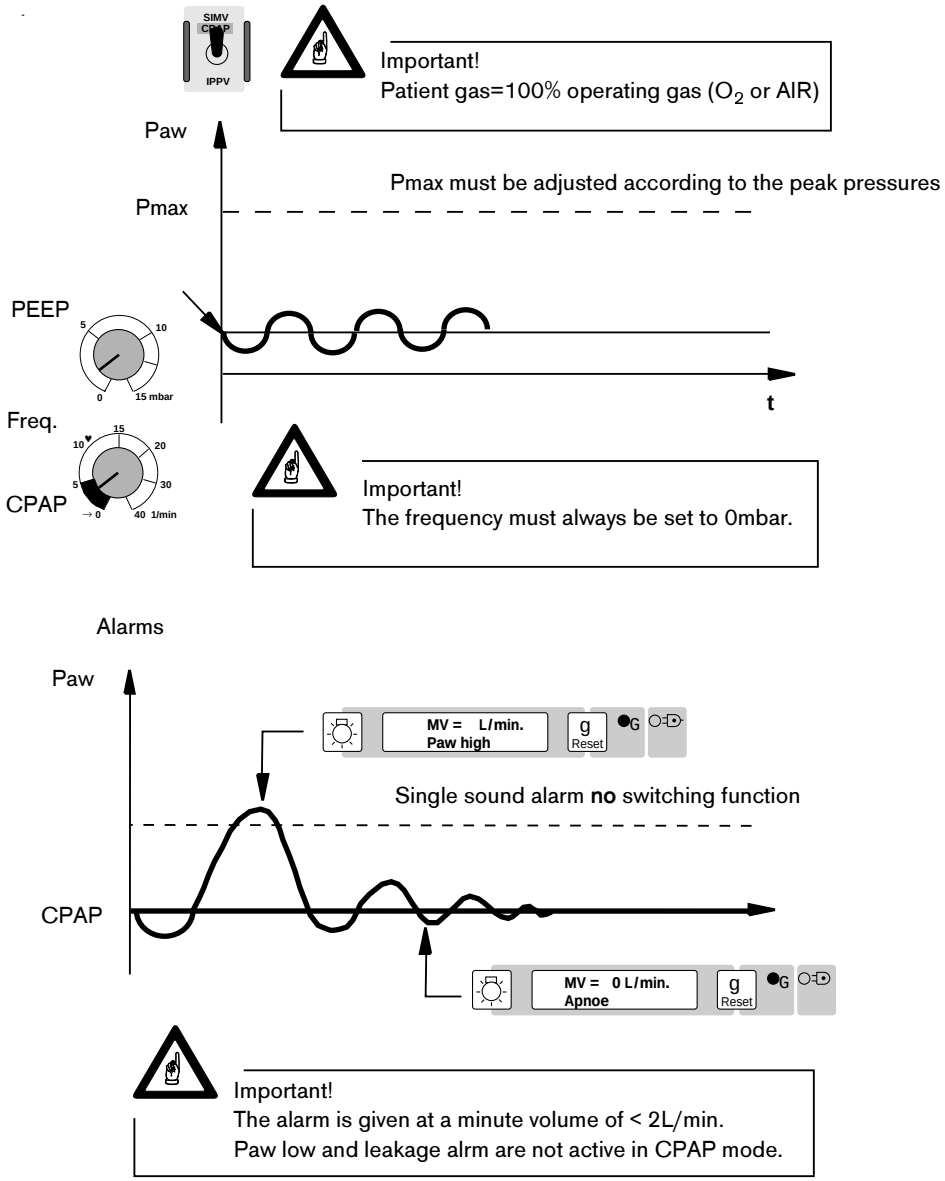

Fig. 10: CPAP

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6 Functional Diagram

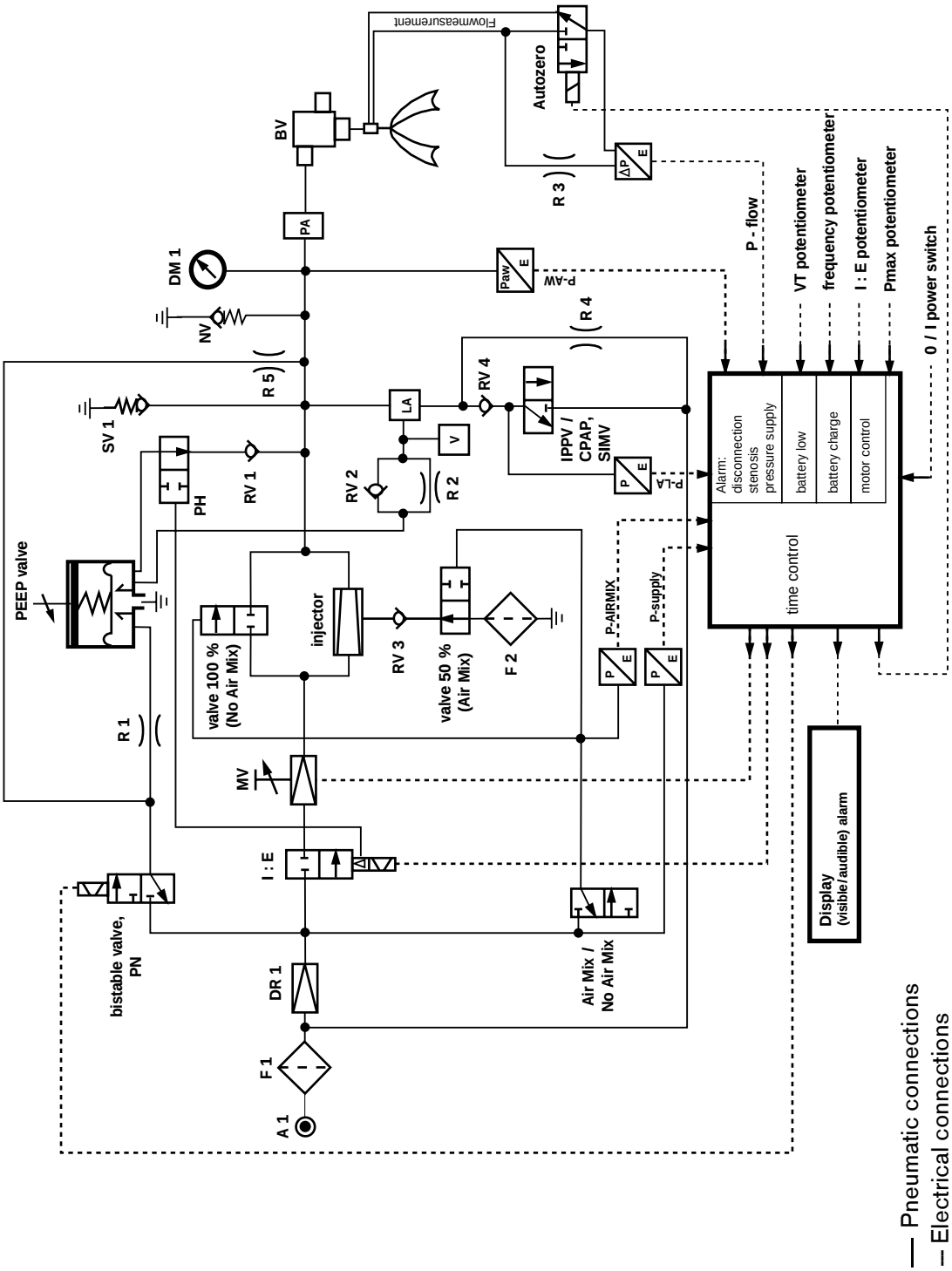

Fig. 11: Oxylog 2000 Functional Diagram

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Legend

A1	Gas connection	
F1	Filter element	
DR1	Pressure regulator	
PN valve	bistable PN valve (electrical)	
I:E valve	bistable I:E Ventil (electrical), Software 2.00 mono stable	
MV	Minute volume (electrical/pneumatic)	
50% valve	2/2-way valve (pneumatic)	
100% valve	2/2-way valve (pneumatic)	
PH	2/2-way valve (pneumatic)	
PEEP	PEEP valve (pneumatic)	
AIR MIX/NO AIR MIX	3/2-way valve (pneumatic)	
IPPV/CPAP SIMV	3/2-way valve (pneumatic)	
Autozero	3/2-way valve (electrical)	
SV 1	Safety valve	
NV	Emergency air valve	
DM 1	Manometer	
PA	Patient connection	
HS	Hose system	
BV	Ventilation valve with flowmeter	
LA	Lung demand valve	
Filter		
Injector		
R1	0.5 L/min restrictor (2.5 bar)	
R2	0.7 L/min restrictor (0.5 bar)	
R3	1.1 L/min restrictor (0.5 bar)	
R4	Insert dosage Ø = 0.42 mm	
R5	0.5 L/min restrictor (2.5 bar)	
RV1	Check valve	
RV2	Check valve	
RV3	Check valve	
RV4	Check valve	
P/E P-AIR MIX	Pressure sensor	AIR MIX
P/E P-supply	Pressure sensor	Supply
P/E P-LA	Pressure sensor	Lung demand valve
Paw/E P-AW	Pressure sensor	Airway pressure
ΔP/E P flow	Pressure sensor	Flow measurement
Time control	Control PCB	
Potentiometer	Front panel	
Display		
0/1-switch		
V	4.8 mL volume	

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7 Gas Flow

7.1 Gas Connection. Ventilator Switched Off

The first pathway that the gas (oxygen or air at 2.7–6.0 bar) follows once it enters the connection A1 leads through the filter F1 and through the pressure regulator DR1. The pressure regulator reduces the gas pressure to a constant level of 2.5 bar (at a 40 L/min flow rate). This pressure is available at the PN valve, at the I:E valve, at the Air Mix/No Air Mix selector, and at the P/E transducer P-supply.

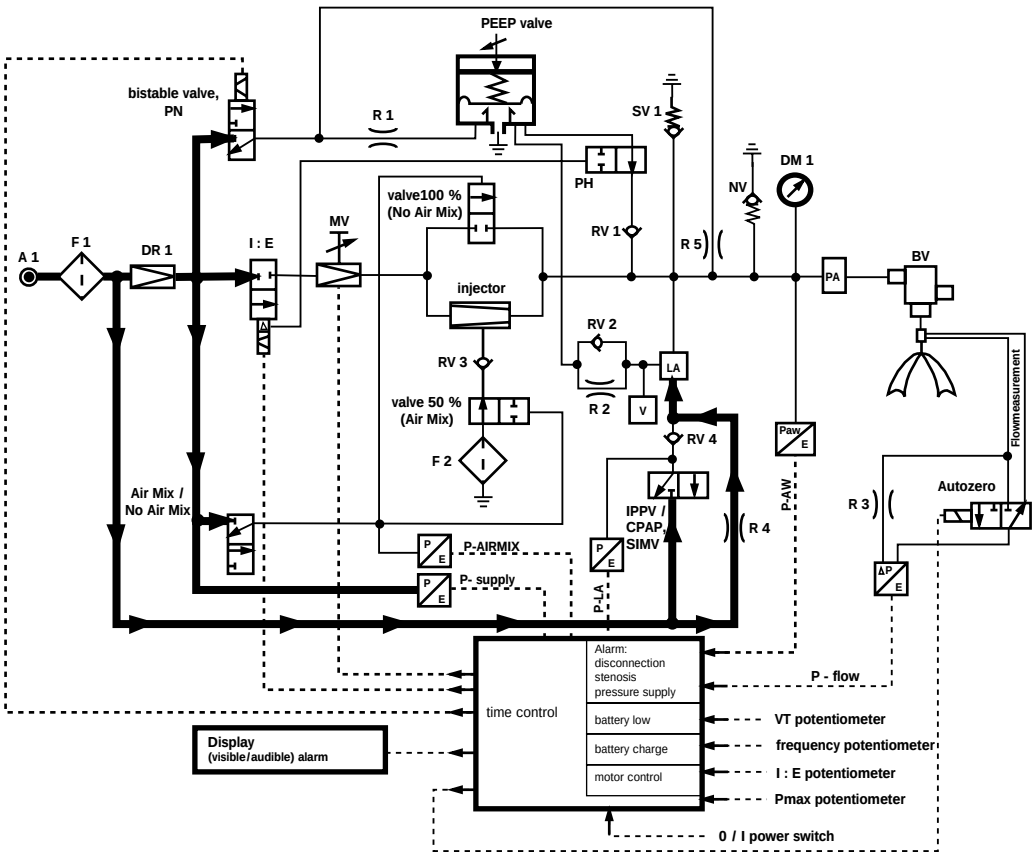

Fig. 12: Ventilator switched off

The second pathway starts between the filter F1 and the pressure regulator DR1. The gas (control pressure) flows to the IPPV/SIMV CPAP selector, and to the lung demand valve LA via the restrictor R4.

Air-Mix (60% Operation)

At Air-Mix position, no control gas flows to the 50% and the 100% valves, that is the ventilator is switched to injector operation.

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7.2 Electrical Power Supply

The ventilator may be powered from an internal NiCd battery pack or from an AlkMn battery pack.

The ventilator can also be powered from an external power supply such as the vehicle power supply system (via the DC/DC converter) or from a power supply unit during in-hospital operation.

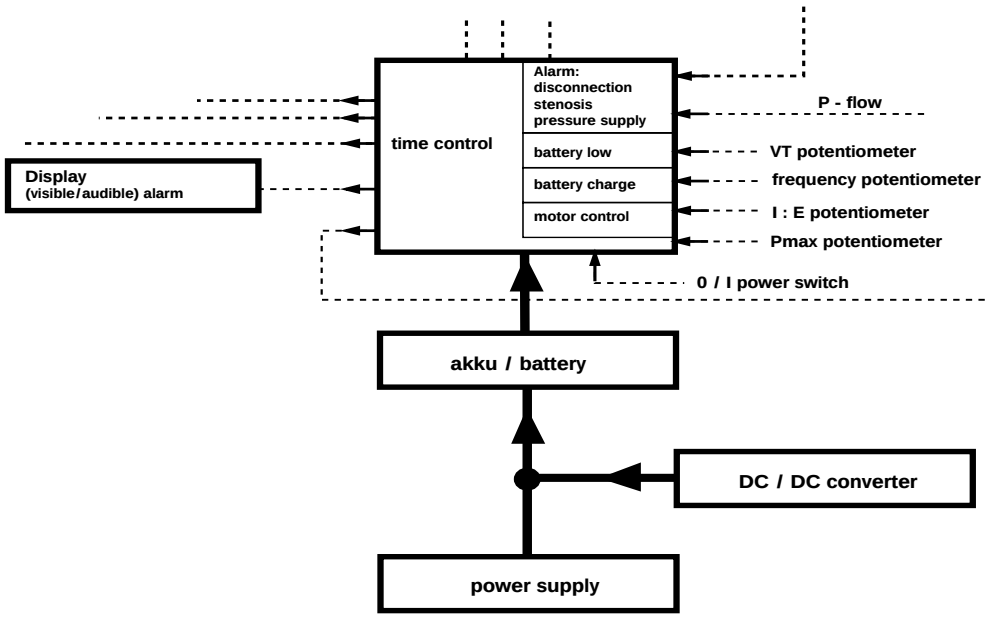

Fig. 13: Electrical power supply

The external power supply is also used to recharge the internal NiCd battery pack.

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7.3 Electronic Inputs

The voltages applied are processed and monitored on the Control PCB.

In addition, the adjusted potentiometer values (VT, frequency, I:E and Pmax) as well as the pressure/flow monitoring values (P-supply, P-AIR MIX, P-LA, P-AW, ΔP-flow) are read in and monitored.

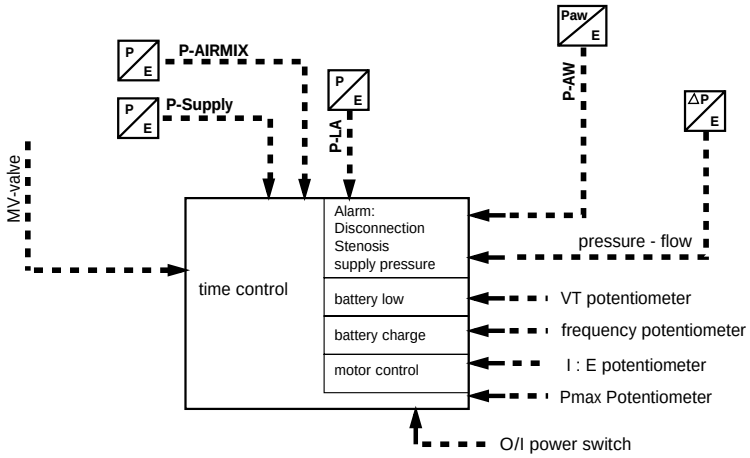

Fig. 14: Electronic inputs

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7.4 Electronic Outputs

The valves PN, I:E, MV, and Autozero are triggered according to the set values. The LCD and the horn are also triggered. The minute volume and the relevant advisory and alarm messages are shown on the display.

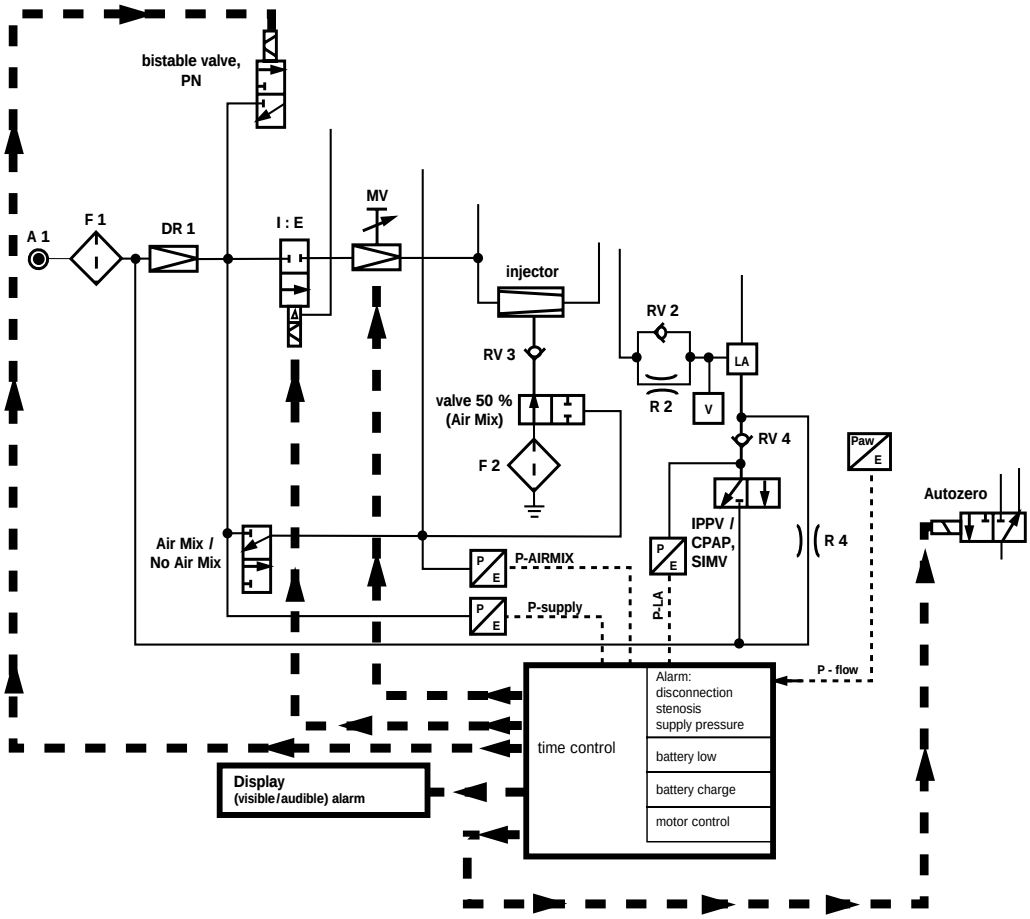

Fig. 15: Electronics outputs

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7.5 Switching on the Ventilator. IPPV, Air Mix Inspiration (50%)

When switching on the equipment, the bistable valve PN will be triggered (opened) electrically. It remains in this position until the ventilator is switched off. The gas flows into the PEEP control system via the valve PN and the fixed restrictor R1 (0.5 L/min). This gas is used during expiration.

Gas also flows into the inspiratory branch through the fixed restrictor R5 (0.5 L/min). The task of this constant flow is to compensate for minor leakages which otherwise would lead to fluctuations in the PEEP pressure.

The bistable valve I:E is also triggered (opened) electrically. The gas from the supply flows to the changeover valve PH thereby interrupting the connection to the PEEP valve. At the same time, it flows to the minute valve that adjusts according to the pre-selected values (MV, I:E, frequency). From there, it flows to the injector which draws in additional ambient air through the check valve RV3, the 5% valve (Air Mix) and the filter F2. This gas mixture is delivered to the patient through the hose system and the ventilation valve BV. The inspiratory ventilation pressure is displayed on the manometer DM1 and monitored by the Paw pressure sensor. The Paw/E pressure sensor generates the apnea and leakage alarms. The supply pressure is monitored via the pressure sensor P-supply.

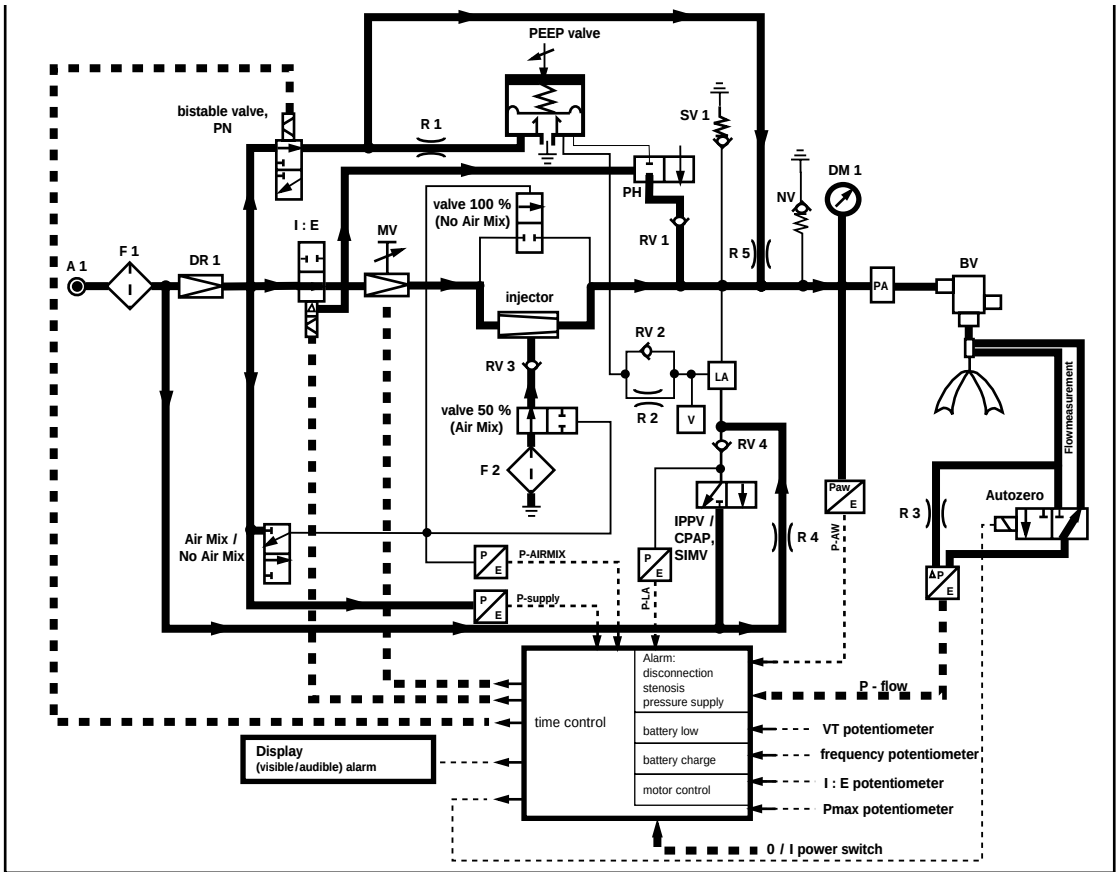

Fig. 16: IPPV Inspiration

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7.6 Bistable Valves

The bistable valves I:E and PN only receive a current pulse of approx. 50 ms when they are switched on or off. This current pulse is designed to set the valves from one stable position into the other. This means the valves consume current only during the switching process.

In software version 2.00 or higher the I:E-valve will be a monostable valve instead of a bistable valve.

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7.7 IPPV Expiration

The I:E valve is switched off after the inspiratory time (TI:TE) is over. Now expiration starts. The PH changeover valve is activated. This means that the gas in the ventilation hose is vented to atmosphere through the PH valve and the PEEP valve. The patient can breathe out to atmosphere through the flow valve and the ventilation valve (BV). The expiratory flow is measured by the sensor P-flow and shown on the display.

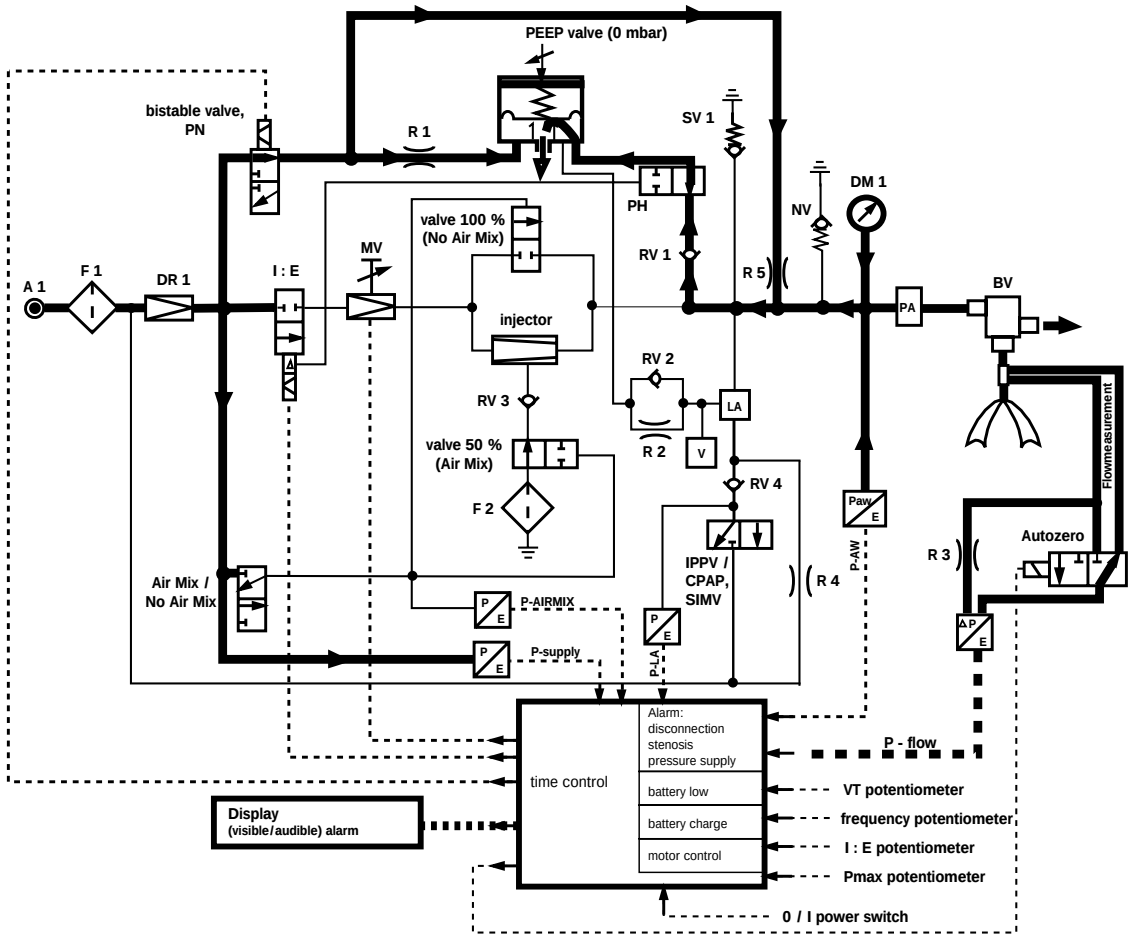

Fig. 17: IPPV expiration

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7.8 IPPV Expiration with PEEP > 0 mbar (CPPV)

When the PEEP vavle is set to > 0 mbar, a spring force acts on the diaphragm. This means, during expiration the inspiratory pressure can be vented to atmosphere only up to the set value. In order to stabilize the set PEEP value and to dampen the system, a defined flow of 0.5 L/min is allowed to enter into the PEEP control system through the restrictor R 1. Due to the surface ratio of 1:1, the pressure on the patient side is about the same as that on the equipment side. This enables measuring the PEEP pressure with the manometer DM1 without using an additional pressure measuring line. The patient can only breathe out up to the set pressure, i.e. a certain pressure (PEEP) remains in the lungs.

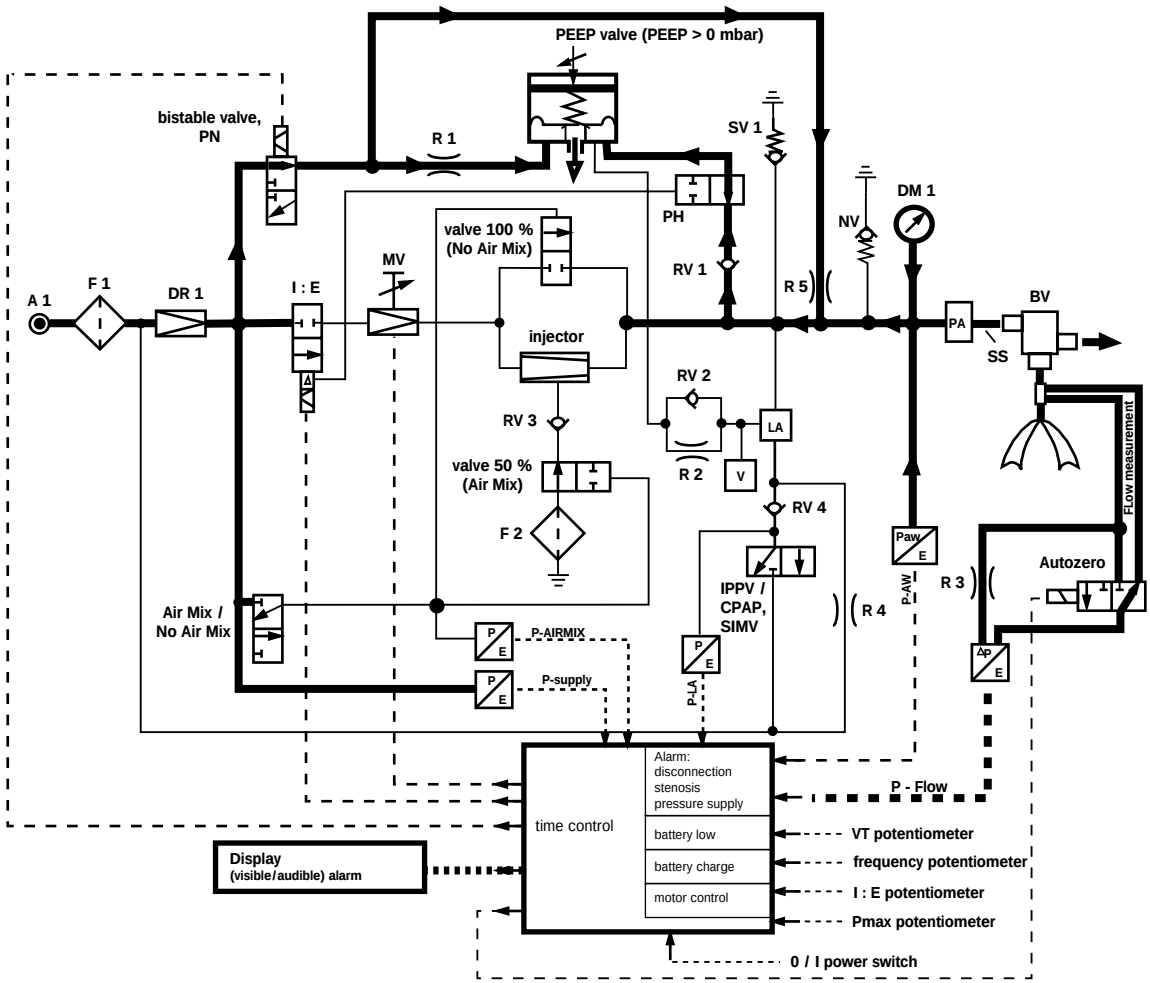

Fig. 18: IPPV with PEEP (CPPV)

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7.9 IPPV, inspiration, No Air Mix (100%)

The No Air Mix position (100% operating gas) is set with the mechanical 3/2-way valve. The gas flows to the 50% valve and the 100% valve which are changed over. As a result, no gas can be drawn in through the injector any more. The gas is delivered to the patient through the 100% valve. The control system receives a signal about the switching position from the P-AIR MIX pressure sensor. The control system makes sure that the minute volume valve MV is re-adjusted so that the patient gets the same volume as in the Air Mix position.

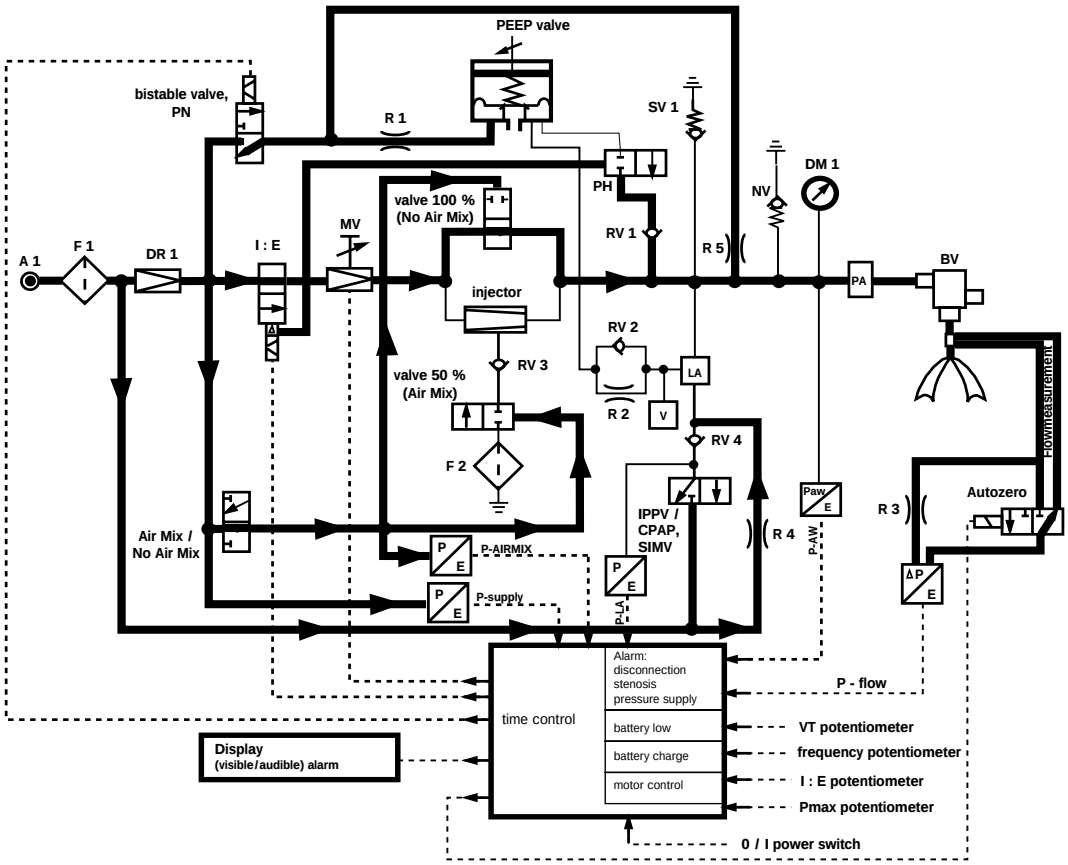

Fig. 19: IPPV inspiration, No Air Mix

7.10 SIPPV (Synchronized IPPV)

The SIPPV operating mode is available for software 3.xx and all higher software versions.

SIPPV is controlled ventilation which allows the patient to trigger mandatory strokes. The operating mode selector switch is set to the position IPPV/SIPPV. The operating mode SIPPV is activated in the menu. The mandatory strokes are triggered via the flow sensor if the patient is receiving a flow of at least 3 L/min from the system.

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7.11 Spontaneous Breathing (PEEP = 0)

The lung demand valve LA is continually supplied with gas (pre-triggered) through the restrictor R4. This is to avoid a pressure surge (Paw) during changeover from IPPV to CPAP/SIMV. In order to set the CPAP mode, the mechanical 3/2-way valve must be adjusted to CPAP/SIMV. The frequency must be set to 0 min^{-1}. The lung demand valve LA is supplied with gas via the 3/2-way valve CPAP/SIMV and the check valve RV4. This gas is also on standby at the P-LA pressure switch. This switch sends an electrical switch-position signal to the control system. Delivery during the first stroke of the lung demand valve is restricted by the restrictor R 4 (“LA biased”). As soon as the patient’s inspiration effort exceeds 1 mbar, the lung demand valve opens. The patient is supplied with gas until the adjusted CPAP-pressure is reached.

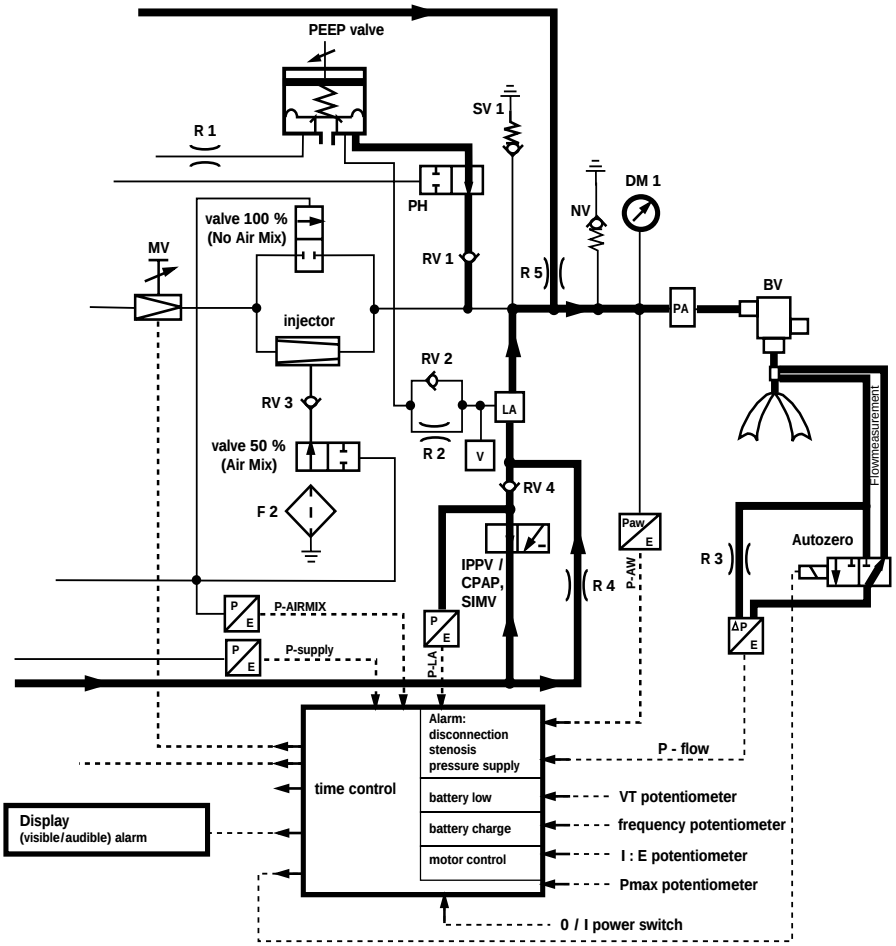

Fig. 20: Spontaneous breathing

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7.12 CPAP (PEEP > 0 mbar)

The PEEP valve is adjusted as described under IPPV-PEEP.

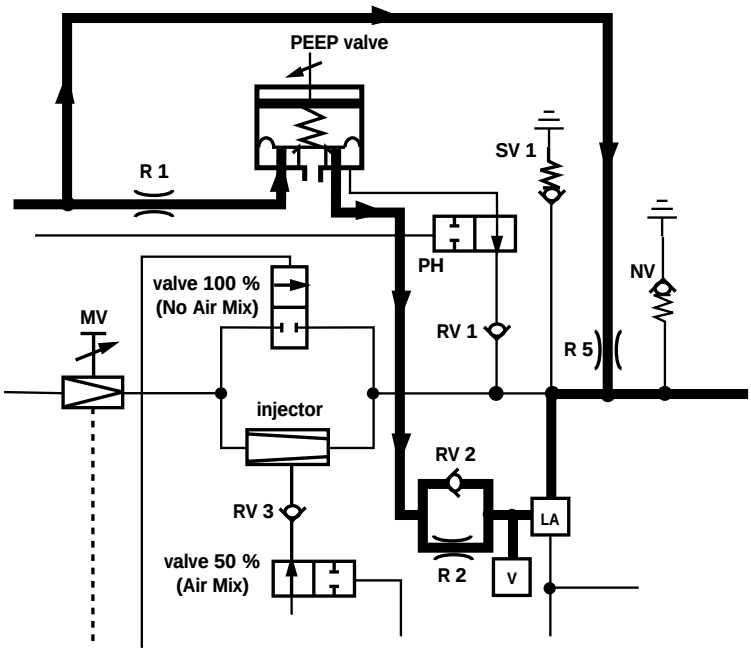

Fig. 21: CPAP

A positive pressure is built up above the control diaphragm in the lung demand valve (up to the patient) via the check valve RV 2 and the restrictor R 2. The check valve RV 2 enables a fast buildup of pressure, the restrictor R 2 restricts this pressure.

The check valve RV1 is necessary to bring the CPAP control pressure via the combination RV2 and R2 to the control input of the demand valve and not escape over the PH-valve in the hose system.

In the CPAP mode 100% operating gas (O_2 or medical air) is delivered to the patient. The Air Mix/No Air Mix switch is not relevant.

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7.13 SIMV

SIMV is a combination of IPPV and CPAP.

Depending on the position of the switch, the volume of the controlled ventilation strokes is approx. 60% O_2 (Air Mix) or 100% O_2 (No Air Mix). The spontaneously breathed volume is always 100% of the supplied operating gas (either 21% O_2 with medical air supply or 100% O_2 with oxygen supply). The mechanical 3/2-way valve is set to SIMV/CPAP and the frequency is set to > 5 min^{-1}. The process is the same as described under IPPV and CPAP except for the time window at the beginning of a new mechanical ventilation. This time window is permanently set to approx. 5 seconds and is activated by the pressure at the pressure sensor P-LA. Triggering the ventilation in the time window (synchronization) occurs via the flow sensor. The flow sensor is required for synchronization of the mechanical ventilation. The frequency is kept at a constant value (see setting).

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7.14 Pmax

The level of the ventilation pressure is limited via the Pmax setting (20–60 mbar). As soon as this limit has been reached, the ventilator will immediately change over to expiration. The gas flow to the patient is interrupted. As a result, the ventilator does not operate at a constant volume any more and the minute volume decreases.

The Pmax can be set to 80 mbar in software 3.xx and all higher software versions. This setting limits the airway pressure to between 60 and 80 mbar using the safety valve. A single tone signalizes any problems which occur. If the airway pressure increases to over 80 mbar, the unit switches over to expiration.

7.15 Safety Valve

Should the Pmax value be exceeded considerably or the Pmax control fail, the ventilation pressure will be reduced via an independent mechanical safety valve SV 1. This safety valve is permanently set to an operating pressure of 60-80 mbar.

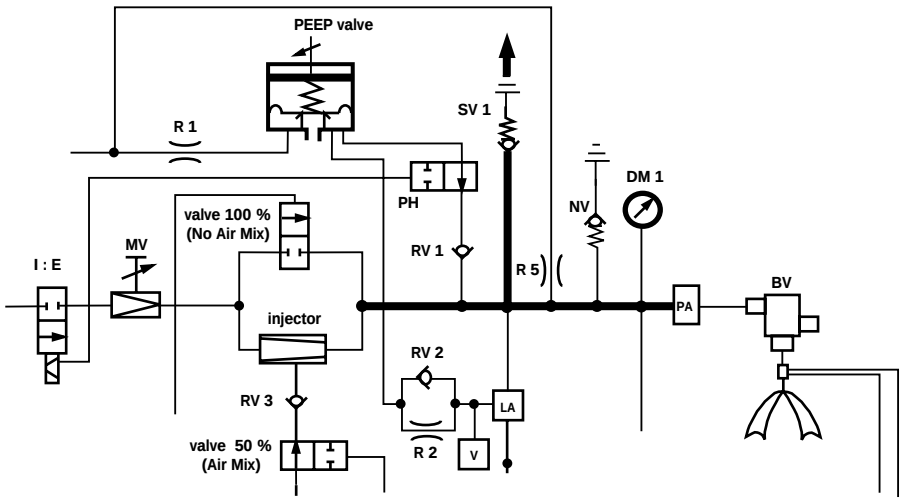

Fig. 22: Safety valve

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7.16 Emergency Air Valve

The emergency air valve NV enables spontaneous breathing of ambient air in the event of a gas supply failure or any malfunction in the ventilator. The opening pressure of the emergency air valve is greater than –11.5 mbar.

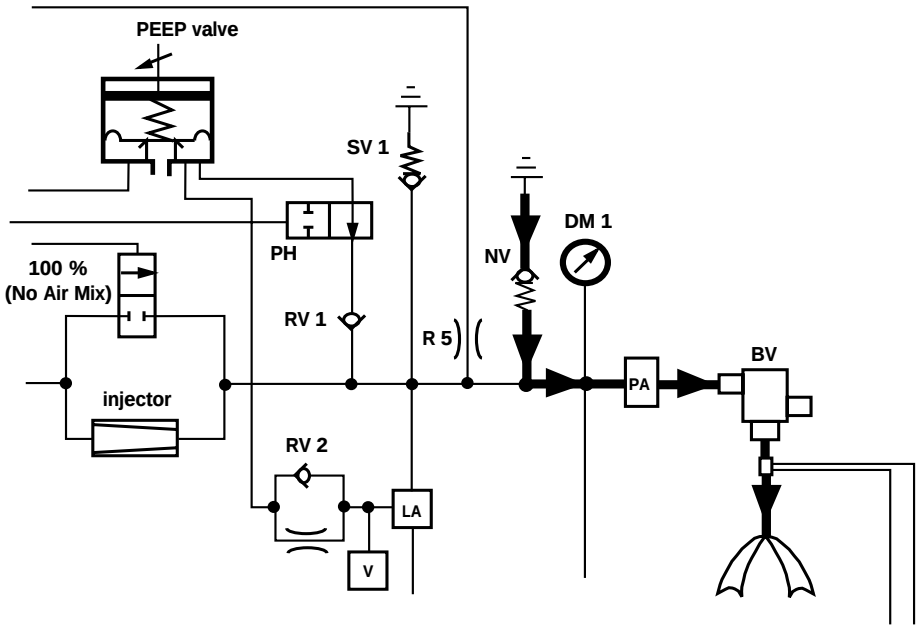

Fig. 23: Emergency air valve

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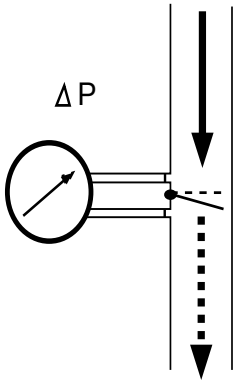
7.17 Flow Measurement, Autozero

Flow measurement is based on the differential pressure measurement principle.



ΔP results from the pressure difference (dynamic pressure in the measuring lines).

Fig. 24: Flow measurement principle

These pressures are measured by the pressure sensor P-flow and processed in the control system. The restrictor R 3 equalizes the resistance of the Autozero valve so that the same resistance is available in the two hoses.

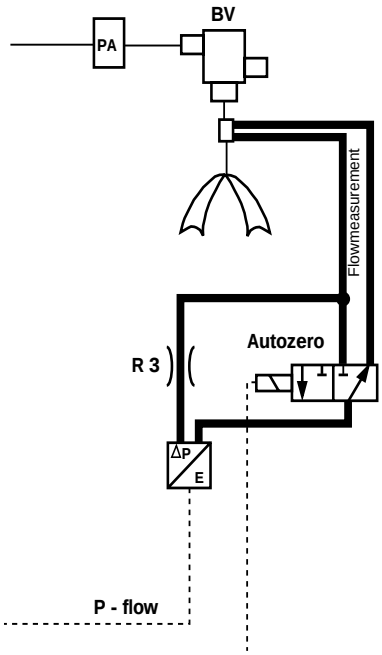


Fig. 25: Flow measurement

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In order to compensate for a pressure-sensor drift, the pressure sensor is shorted every 3 minutes via the Autozero valve. This calibrates the pressure sensor.

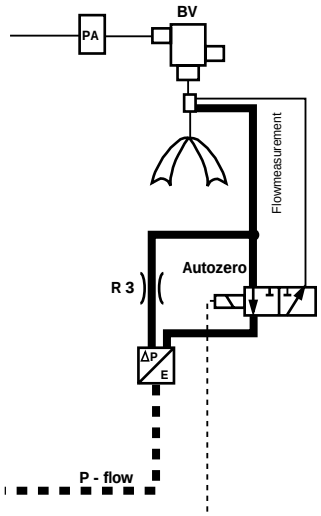

Fig. 26: Autozero

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8 Ventilator Holder

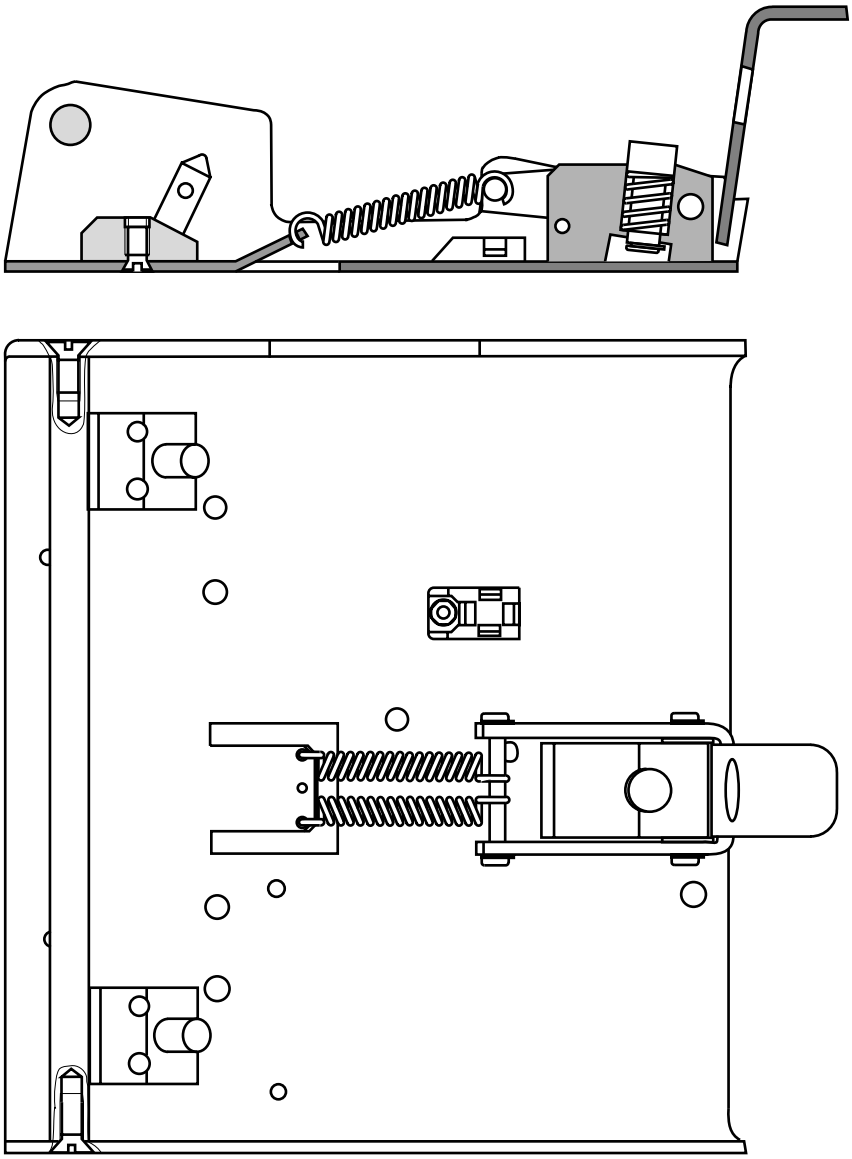

Fig. 27: Ventilator holder

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9 Oxylog 2000 Front Plate (Software 1.xx)

Front plate,
Standard version

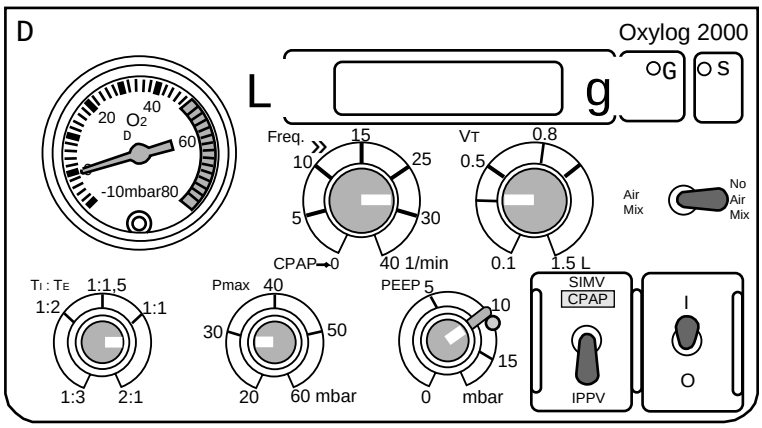

Fig. 28: Front plate of the Oxylog 2000

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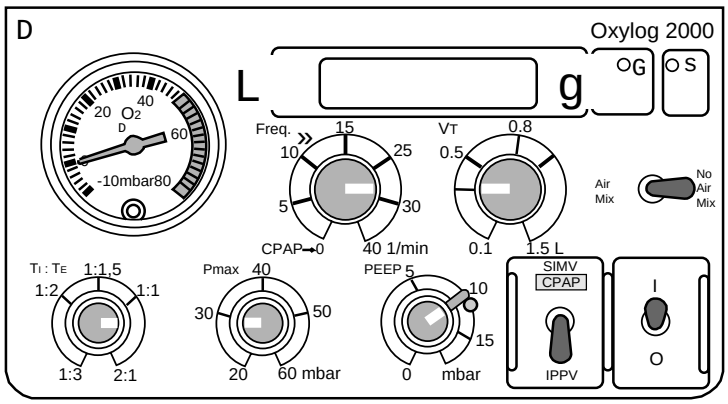
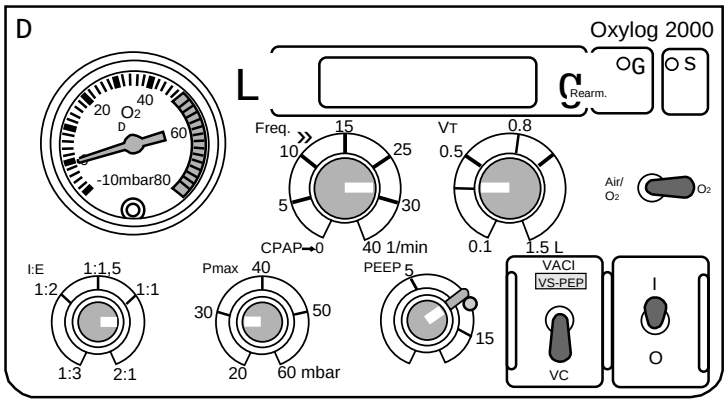
10 Oxylog 2000 Front Plates (Software 2.xx)

Front plate,
Standard version



Front plate, french version



Front plate,
American version

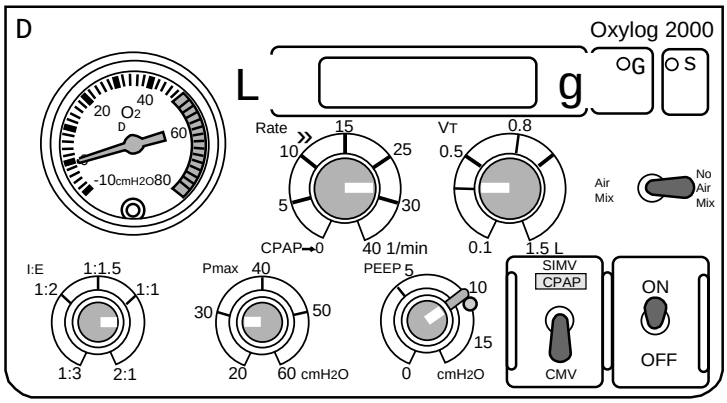


Fig. 29: Front plates of the Oxylog 2000

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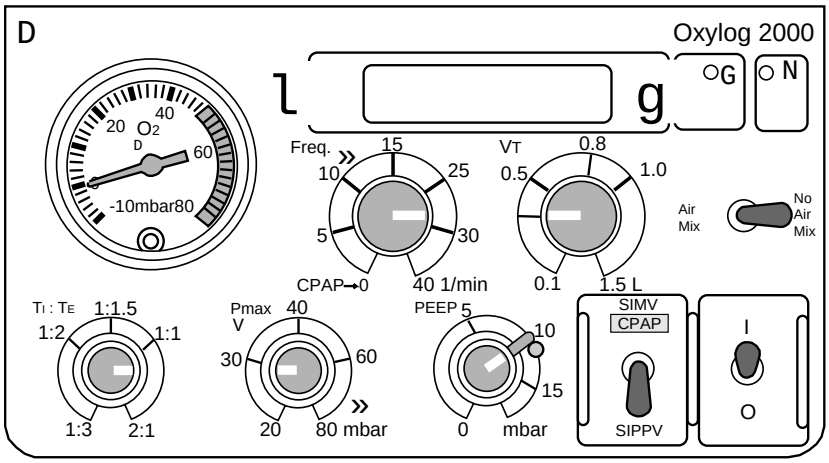
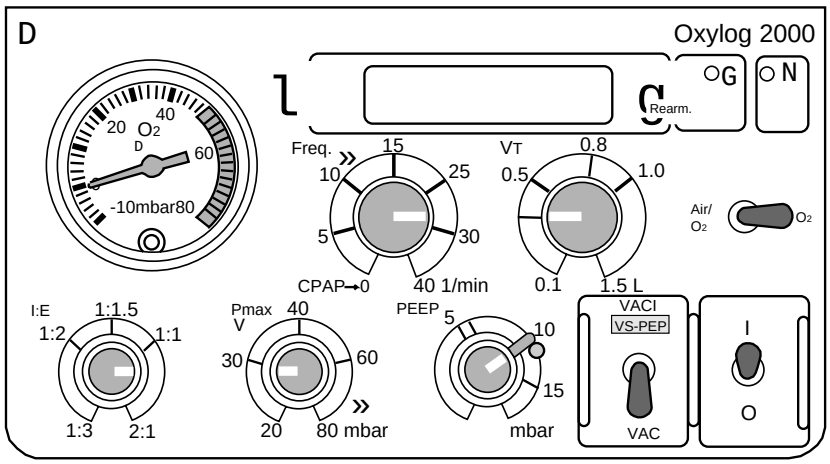
11. Oxylog 2000 Front Plates (SW 3.xx)

Front Plate:
Standard version



Front Plate:
French version



Front Plate:
American version

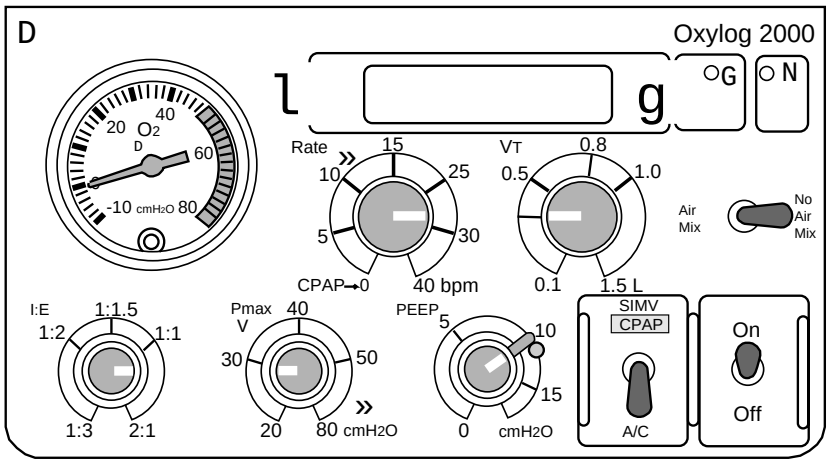


Fig. 30: Front Plates, Oxylog 2000

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12 Pneumatic Assembly

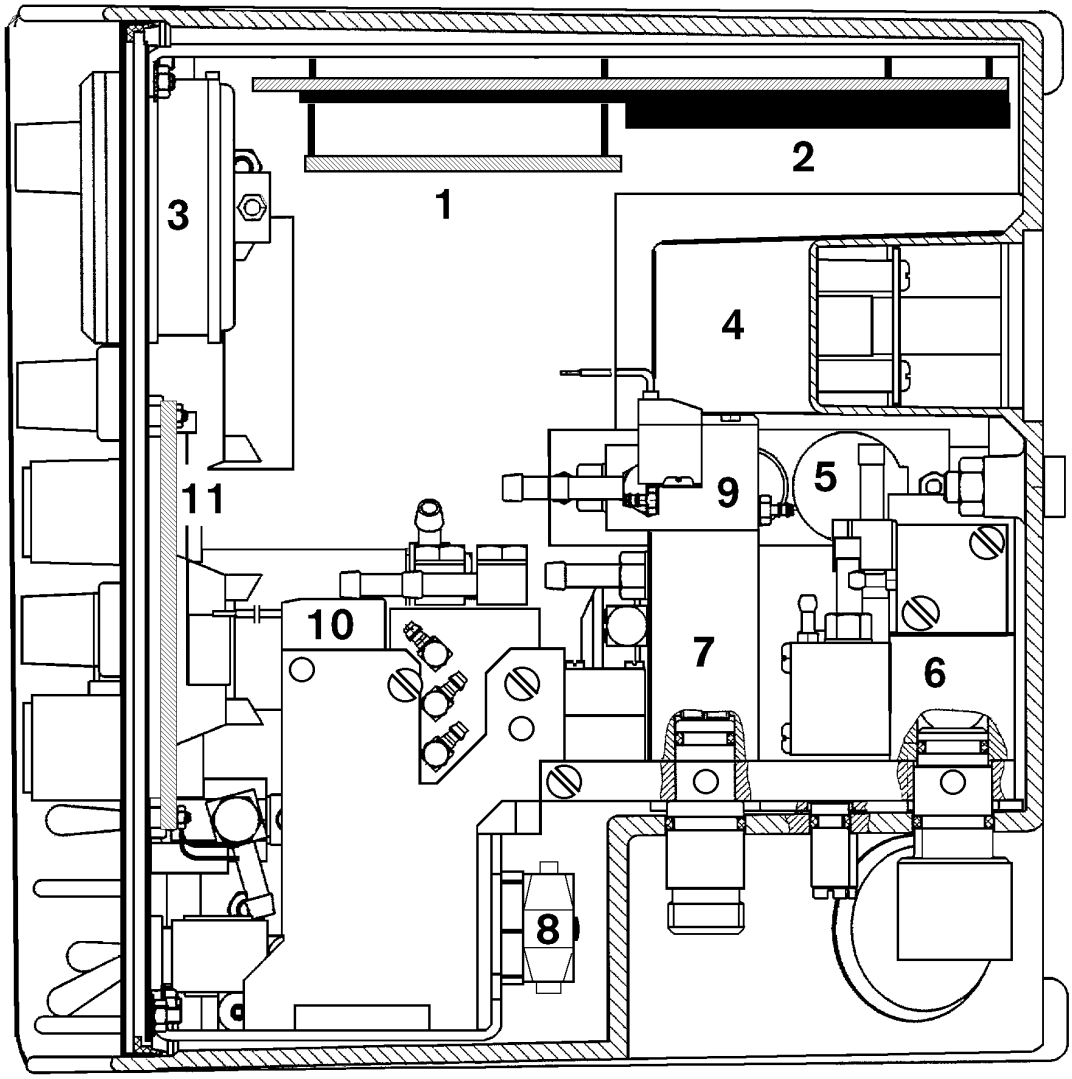

Fig. 31: Location of the subassemblies

Legend

1 Sensor PCB
2 Control PCB
3 Manometer
4 NiCd or AlkMn battery pack
5 MV valve
6 Pneumatic assembly
7 Gas supply inlet
8 Pressure reducer
9 Autozero valve
10 I:E valve, PN valve
11 Display PCB

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13 Lung Demand Valve

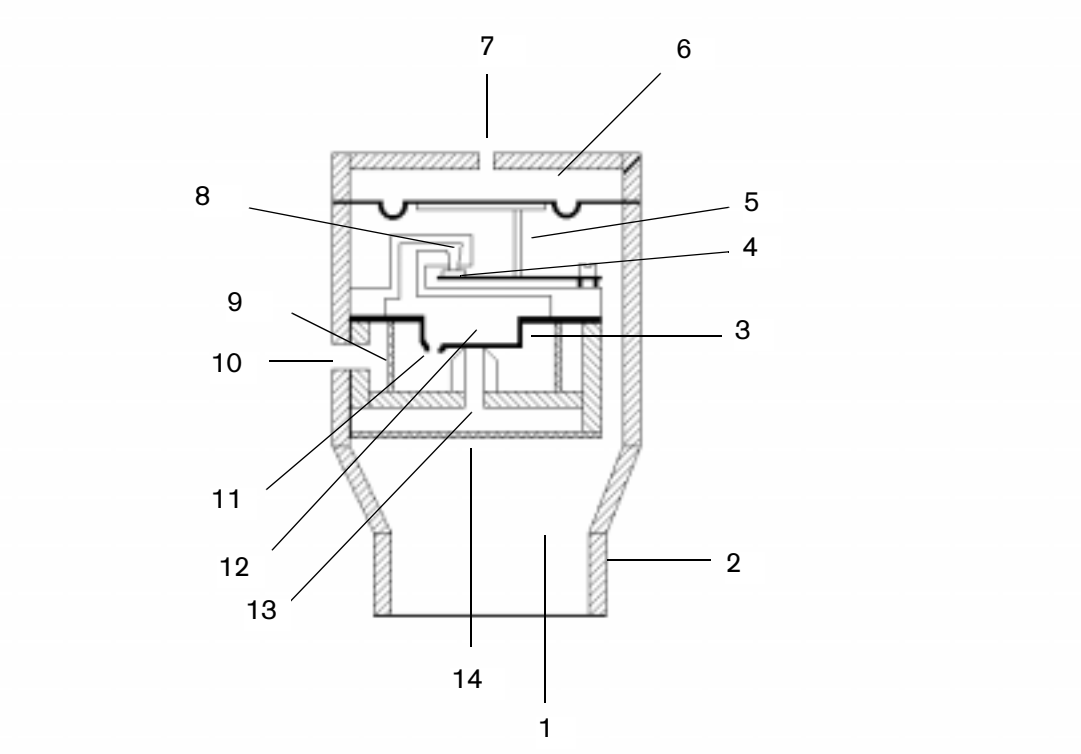

Fig. 32: Sectional view of the lung demand valve

Legend

1	Patient connection	**11**	Chamber
2	Enclosure	**12**	Inlet port
3	Control diaphragm	**13**	Crater
4	Locking pin	**14**	Sintered filter
5	Connecting rod		
6	Control diaphragm		
7	Connection to the PEEP valve		
8	Port		
9	Sintered filter		
10	Control pressure connection		

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13.1 Gas Flow in the Lung Demand Valve

The control pressure connection (**10**) is directly connected to the supply pressure via the IPPV/CPAP switch. The set PEEP pressure is available at the connection to the PEEP valve (**7**) and the control diaphragm (**6**) of the lung demand valve. The patient connection (**1**) is connected to the patient via the pneumatics unit.

The patient's inspiration effort generates a vacuum at the patient connection (**1**). The pressure above the connection to the PEEP valve (**7**) is between 0 and 15 mbar (PEEP).

The control diaphragm (**6**) is pushed down by the inspiration effort of the patient. When the control diaphragm descends it carries with it the connecting rod (**5**) which pushes the locking pin (**4**) down and opens the port (**8**). The pressure in the chamber (**11**) decreases. The control diaphragm (**3**) moves up and the gas is delivered to the patient through the crater (**13**) and the sintered filter (**14**).

As soon as the patient's inspiration effort is finished the diaphragm (**6**) moves up and carries with it the connecting rod (**5**) which pulls the locking pin (**4**) up and closes the port (**8**)**.** The pressure in the chamber (**11**) increases and the control diaphragm (**3**) closes the crater. The gas flow to the patient is interrupted.

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14 Pneumatik-Unit

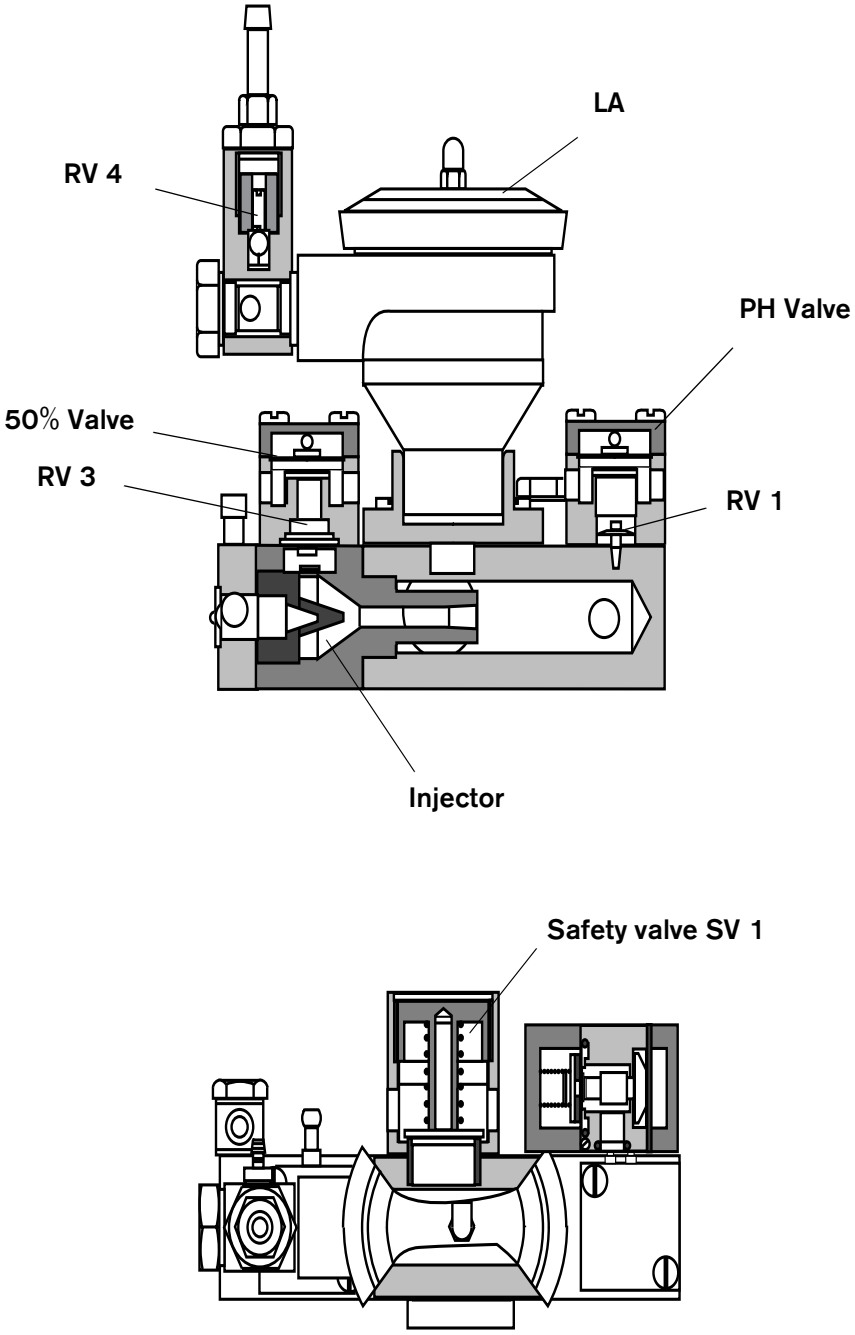

Fig. 33: Pneumatik-unit

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15 PEEP Valve

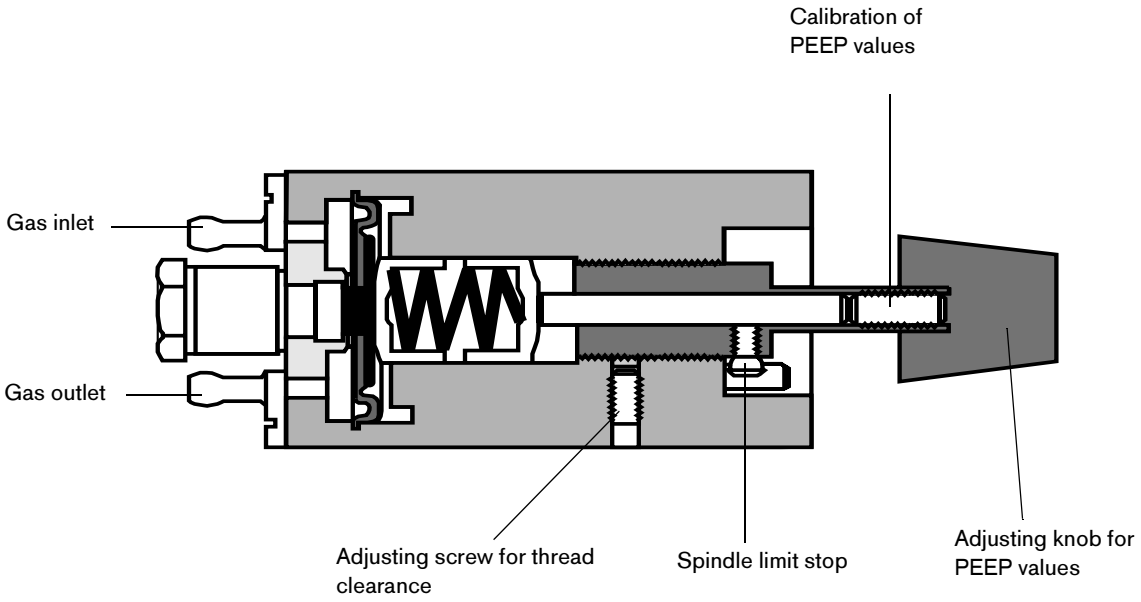

Fig. 34: Sectional view of the PEEP valve

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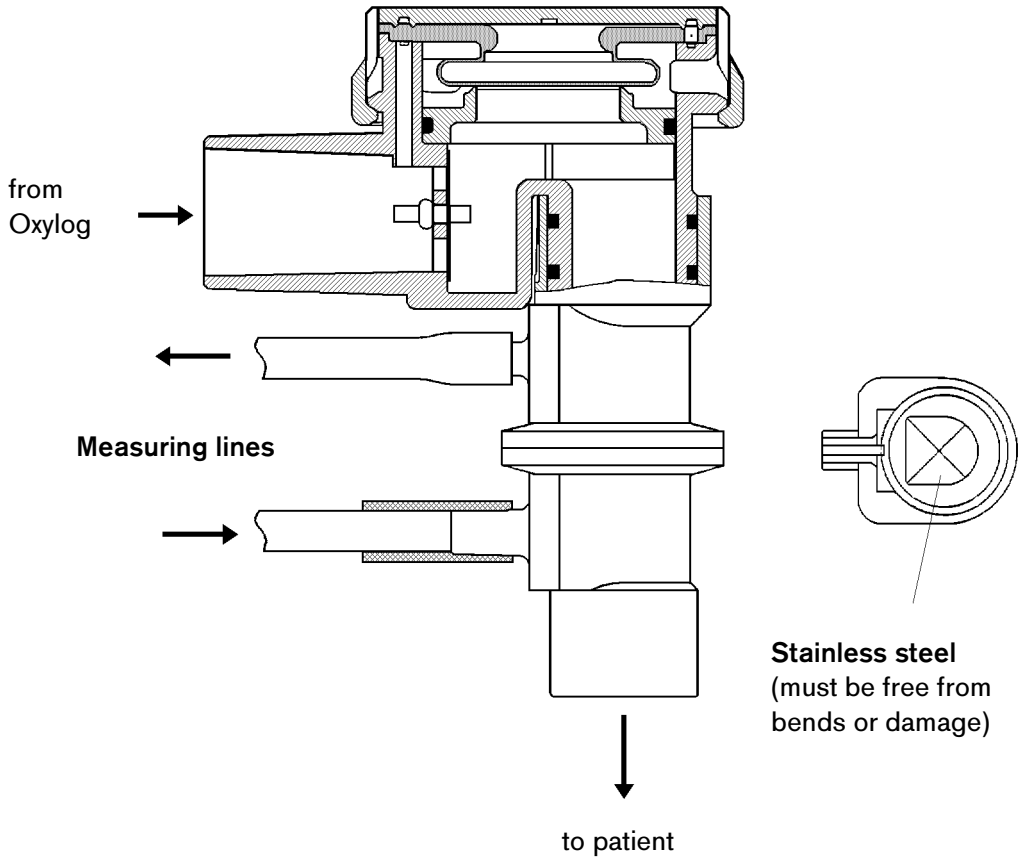
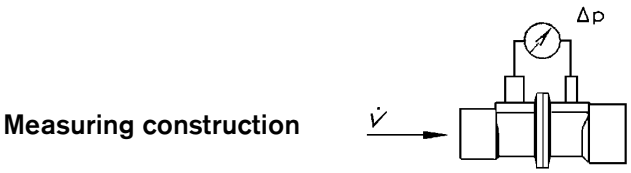
16 Ventilation Valve





Flow range:
2 to 120 L

Accuracy:
±12% or ±0.8 L/min (the higher tolerance value applies)

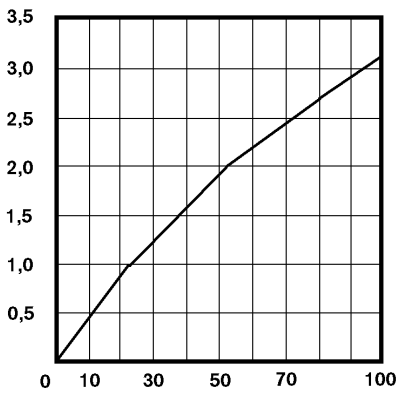


Fig. 35: View of the ventilation valve

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17 Pressure Regulator

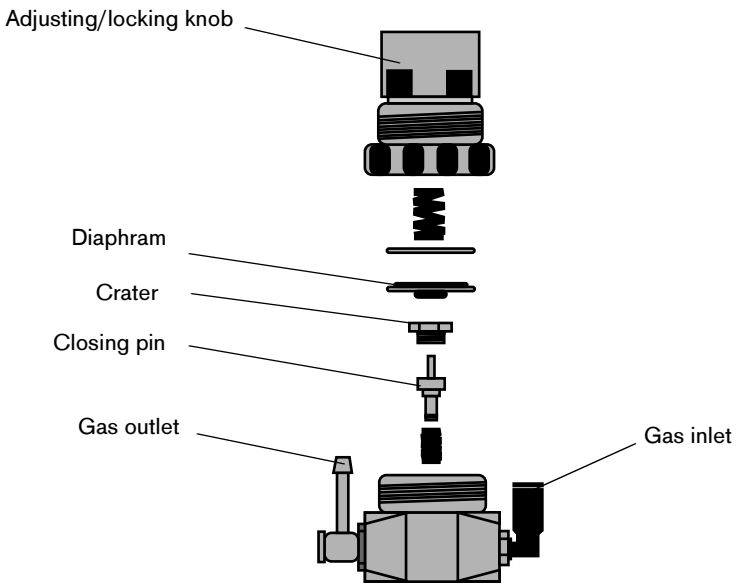

Fig. 36: Exploded View of the pressure reducer

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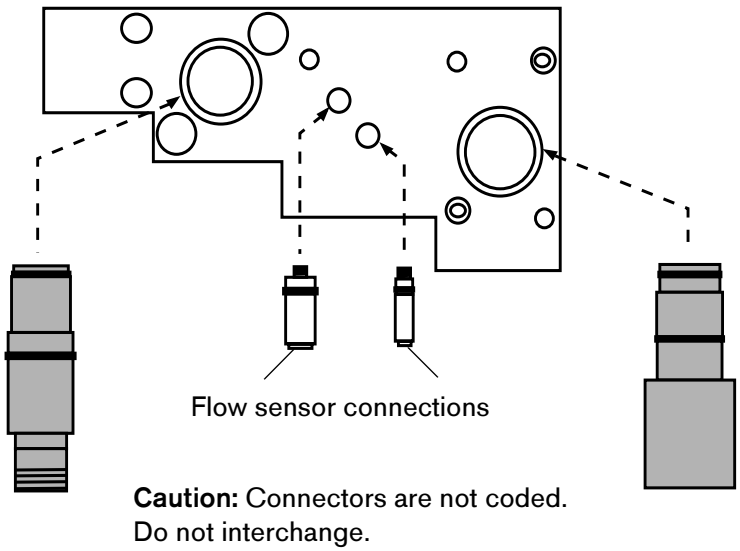
18 Gas Inlet



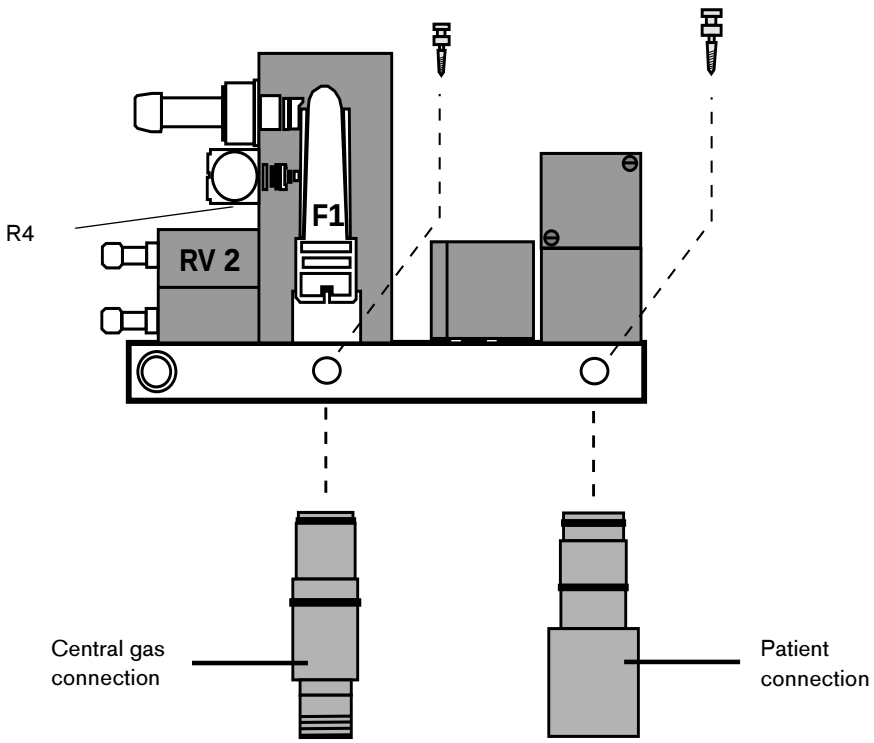


Fig. 37: Gas inlet structure

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19 MV Valve

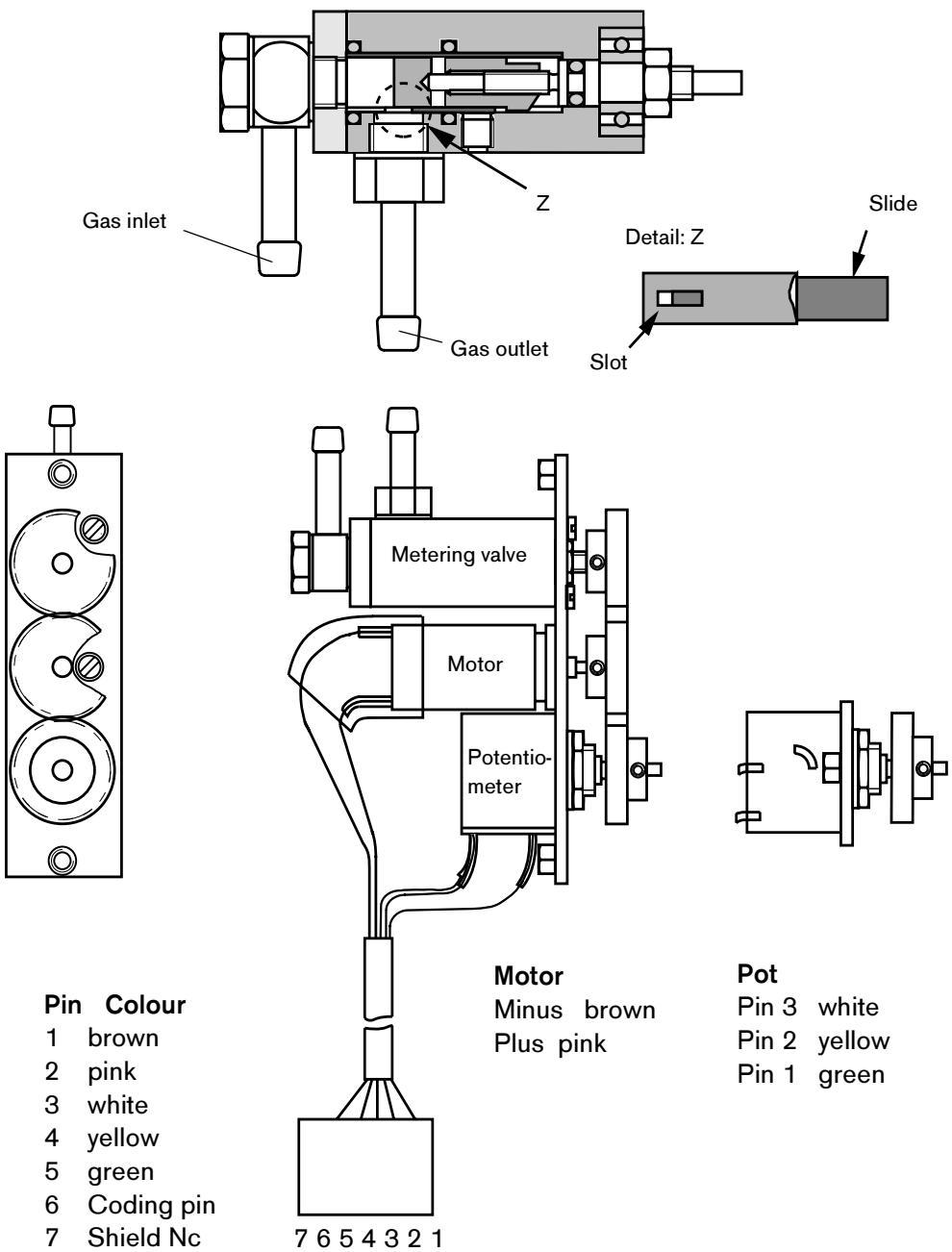

Fig. 38: MV valve

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20. Patient Valve for Oxylog 2000 HBO

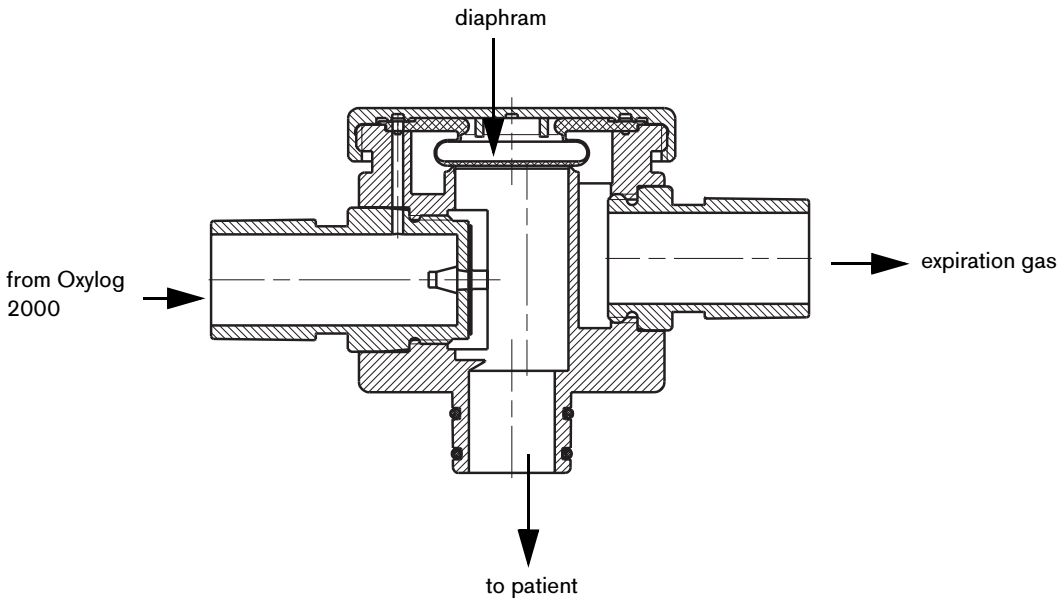

Fig. 39: Patient valve for Oxylog 2000 HBO

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21 Control PCB

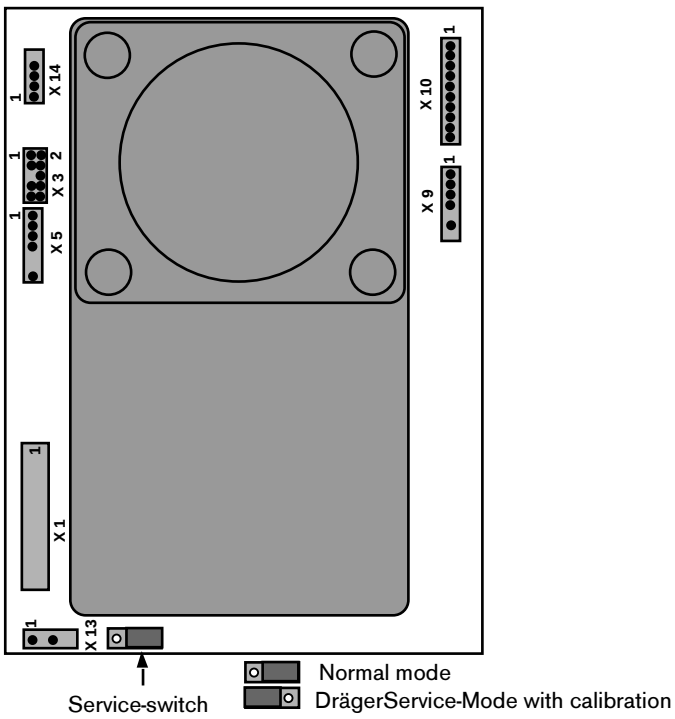

Fig. 40: Control PCB

Note: The service-switch is no longer functional in software version 2.00 or higher versions.

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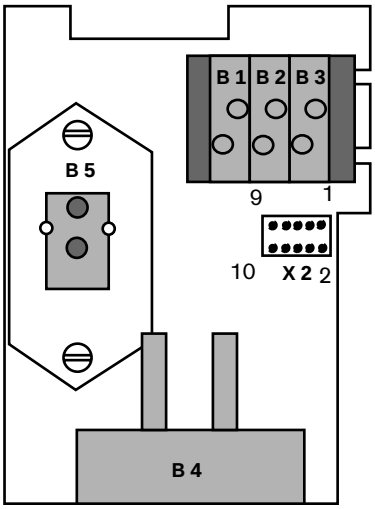
22 Sensor PCB



Pressure sensors

B1 –> P-VERS
B2 –> P-AIRMIX
B3 –> P-LA
B4 –> P-Flow
B5 –> P-AW

Fig. 41: Sensor PCB

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23 Display PCB

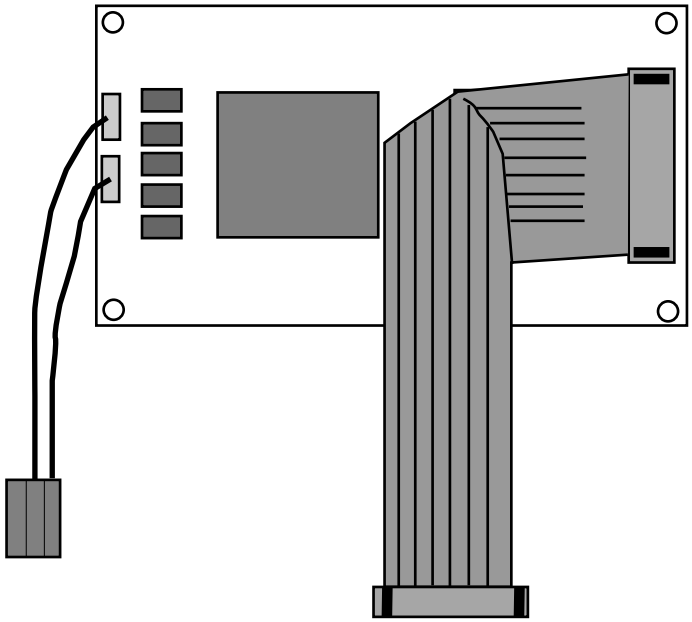

Fig. 42: Display PCB

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24 Fuse PCB

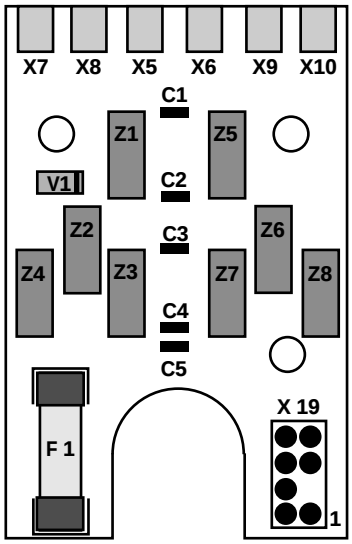

Fig. 43: Fuse PCB

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